

Assessing differences in episodic and semantic memory in healthy ageing and in people at increased genetic risk for late-onset Alzheimer's Disease

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Thesis portfolio abstract

Cognitive and genetic markers in preclinical Alzheimer's Disease (AD) represent a promising research ground for early diagnosis and intervention. The genetic variant Apolipoprotein epsilon 4 (*APOE* ϵ 4) is linked to higher risk of developing AD and research investigating cognitive functioning in people at risk could help identify markers of preclinical AD. Past research observed that episodic memory is usually impaired in *APOE* ϵ 4 carriers, while semantic memory has received less attention. This thesis aimed to assess whether the cognitive impact of *APOE* ϵ 4 genotype also affects other aspects of declarative memory, such as personal and general semantic memory. A systematic review was carried out to investigate whether *APOE* ϵ 4 genotype affects semantic memory functioning in healthy adults at increased genetic risk of developing AD. An empirical study aimed to clarify whether the impact of *APOE* ϵ 4 on declarative memory is specific to episodic memory, or if it also extends to personal and general forms of semantic memory by using new and traditional autobiographical interview protocols. The results from the systematic review revealed a limited impact of *APOE* ϵ 4 on semantic memory and highlighted the need for more demanding and sensitive tasks designed to measure semantic memory. The empirical findings of the thesis revealed that *APOE* ϵ 4 carriers showed reduced production of on-task and off-task episodic details, while carriers and non-carriers showed equal recall of personal and general semantic memory. These findings increase our understanding of how genetic risk for AD affects memory, and reveal the importance of developing new tasks for less ambiguous comparisons of subtypes of declarative memory findings. The limitations are also discussed, along with recommendations for future research prospects. Altogether, these findings suggest that *APOE* ϵ 4 has a limited impact on semantic memory, and that episodic memory is selectively reduced in healthy older *APOE* ϵ 4 carriers.

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Dedication and Acknowledgements

This thesis is dedicated to the memory of my former schoolteacher and friend Antonio Dellepiane (1955 – 2024), who has been a central figure in my academic and personal development. During the time I was his student between 2008 and 2013, Antonio helped me to discover the beauty of literature, and this had a profound impact on my interests and future aspirations. Our genuine friendship remained solid throughout the years and our conversations will always hold a very special place in my memory.

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Chapter One: Introduction to thesis portfolio

Alzheimer's Disease (AD) is the most common form of neurodegenerative disease and dementia in the world, and it has become one of the most expensive and burdening conditions of this century (Scheltens et al., 2021). The current projections indicate that by 2050 the rates of dementia will triple worldwide, with numbers rising from the current rate of 55 million to more than 150 million people affected globally (Nichols et al., 2022). In the UK, this figure is set to rise to more than 2 million people by 2050 with huge social and financial costs (Chen et al., 2023). AD symptoms present with an early onset (i.e., before the age of 65), or a late onset (i.e., from the age of 65), with most AD cases being considered as late onset (Harman, 2006; Zhang et al., 2020).

Early and accurate detection of AD is important for the screening, diagnosis and subsequent management and care of people affected by this neurodegenerative condition (see Porsteinsson et al., 2021). However, detecting early cognitive deficits in preclinical AD is problematic and clinically challenging, given the significant heterogeneity in normal ageing and AD expression (see Emrani et al., 2020). Early deficits often affect spatial navigation and declarative memory (Coughlan et al., 2018) and once a person receives a diagnosis, cognitive impairments are often fairly pronounced. Late-onset AD can, therefore, elude clinical detection for years and even decades, and this inevitably has a life-changing impact on the quality of life of people receiving such diagnosis and their families and carers (Rasmussen & Langerman, 2019). With the recent approval and imminent rollout of the first disease-modifying pharmacological treatments for AD (e.g., Donanemab, or Lecanemab; Mintun et al., 2021, see also Laurell et al., 2024), early detection of subtle cognitive markers of AD has become even more important.

Advances in neuroimaging measures, like Positron Emission Tomography (PET), fluorodeoxyglucose PET (FDG-PET) and functional Magnetic Resonance Imaging (fMRI) (for a review see Ewers et al., 2011), in conjunction with AD biomarkers (e.g., beta-amyloid and tau proteins) have dramatically improved the precision of the AD diagnostic criteria (see McKhann et al., 2011). Indeed, changes in brain biochemistry involving biomarkers are now thought to occur approximately 20 years before the onset of classic AD symptoms (Alzheimer's Association, 2019). In this regard, a promising ground of research derives from cognitive and genetic markers in preclinical AD which, along with brain biomarkers and sensitive cognitive assessment, could predict the development of the disease and inform future pharmacological and cognitive interventions (for a review see Jackson et al., 2024).

APOE, or apolipoprotein E, is a protein that transports cholesterol and other fatty substances within brain cells and supplies the central nervous system with essential lipids. *APOE* carries a different version of DNA sequence on chromosome 19, known as an allele, with three major variants or isoforms ($\epsilon 2$, $\epsilon 3$, and $\epsilon 4$), for which every individual inherits one from each parent. Variants in allele genotypes can be homozygous ($\epsilon 2\epsilon 2$, $\epsilon 3\epsilon 3$, $\epsilon 4\epsilon 4$) or heterozygous ($\epsilon 2\epsilon 3$, $\epsilon 2\epsilon 4$, $\epsilon 3\epsilon 4$) and each isoform of the *APOE* protein has distinct structural properties which impact alterations of brain functions. The *APOE* $\epsilon 4$ variant is linked to an increased risk of developing sporadic late-onset Alzheimer's Disease (Corder et al., 1993; Farrer et al., 1997). Genetic risk for AD is dose-dependent (Blacker et al., 1997; Davidson et al., 2006), since $\epsilon 4$ homozygotes carriers ($\epsilon 4\epsilon 4$) have a greater risk of developing AD at an earlier onset as compared to $\epsilon 4$ heterozygotes carriers ($\epsilon 3\epsilon 4$ or $\epsilon 2\epsilon 4$).

This thesis aims to assess the cognitive impact of the *APOE* $\epsilon 4$ genotype on different forms of declarative memory, including episodic memory and also personal and general forms of semantic memory, in healthy people at increased genetic risk of developing AD.

Chapter Two: Systematic Review

Prepared for submission to the journal *Neuroscience & Biobehavioural Reviews* (Elsevier)

Author Guidelines can be found in Appendix A

Semantic Memory in healthy Apolipoprotein ε4 Carriers:

A systematic review

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Abstract

The Apolipoprotein epsilon 4 (*APOE* ϵ 4) genetic variant is notoriously linked to enhanced risk of developing Alzheimer's Disease (AD). Several studies have examined how this allele could influence cognitive functioning in healthy adults and whether ϵ 4 carriers show a subtle cognitive decline that would indicate preclinical AD pathology. Research has predominantly focused on episodic memory, where ϵ 4 carriers are usually impaired, while semantic memory functioning has generally received less attention. To understand whether *APOE* ϵ 4 influences semantic memory functioning, we systematically reviewed the research literature assessing semantic memory in non-clinical adult populations according to the PRISMA guidelines. We reviewed 17 studies, and we found high heterogeneity in how semantic memory is conceptualised and assessed. When tested via classic neuropsychological tests (i.e., verbal fluency, naming, language comprehension, and general knowledge), ϵ 4 carriers did not significantly differ from non-carriers. Instead, carriers showed lower performance when assessed via more complex semantic memory tasks (i.e., longer verbal fluency tasks, autobiographical memory tasks, measures of semantic clustering). The impact of *APOE* ϵ 4 on semantic memory in healthy adults could therefore be restricted to more demanding and specific tasks. Future research investigating autobiographical memory retrieval in ϵ 4 carriers could provide a more sensitive and ecologically valid assessment of semantic memory and would disentangle between personal and general forms of semantic memory.

Highlights

- Apolipoprotein epsilon 4 is linked to increased risk for Alzheimer's Disease.
- In studies with healthy carriers, semantic memory has received less attention.
- Carriers were not impaired in standard neuropsychological tests of semantic memory
- Carriers showed lower performance in more complex and sensitive tasks
- Our findings highlight the need for more sensitive tasks to assess semantic memory

1. Introduction

It has been demonstrated that people carrying the $\epsilon 4$ variant of the *APOE* gene are at increased risk of developing sporadic late-onset Alzheimer's Disease (Corder et al., 1993; Farrer et al., 1997) with an earlier age of onset (Fortea et al., 2024), while those carrying the $\epsilon 2$ allele are at a decreased risk (Reiman et al., 2020, for a review see Suri et al., 2013). Notably, $\epsilon 4$ homozygotes carriers ($\epsilon 4\epsilon 4$) present with greater risk compared $\epsilon 4$ heterozygotes carriers ($\epsilon 3\epsilon 4$ or $\epsilon 2\epsilon 4$), meaning that genetic risk to AD could be dose-dependent (Blacker et al., 1997; Davidson et al., 2006). Despite the presence of $\epsilon 4$ genotype being restricted to only 20 to 25% of the general population in different global regions, the allele is highly present in cases of late-onset AD (i.e., almost half of all cases, see Caselli & Reiman, 2012). A recent study examining clinical, pathological, and biomarker changes in homozygotic *APOE* $\epsilon 4$ carriers (Fortea et al., 2024) concluded that this allele mutation represents a direct cause of late-onset AD and not just a risk factor, as almost all these participants presented with AD brain pathology already from middle age (see also Xu et al., 2024), although having high amyloid burden does not necessarily translate to AD (for a meta-analysis see Jansen et al., 2015).

A plethora of research studies focused their attention on how this allele could influence cognition and cognitive decline in non-demented healthy adults (see O'Donoghue et al., 2018; Small et al., 2004; Wisdom et al., 2011). Meta-analyses looking at the effect of *APOE* on cognition (Small et al., 2004; Wisdom et al., 2011) observed that *APOE* $\epsilon 4$ carriers are predominantly impaired in episodic memory, executive functioning, and, more marginally, perceptual speed. This has, however, produced findings that are difficult to interpret across studies because of variable methodology regarding the age groups involved, the cognitive measures employed, sample sizes, and study designs.

The precise role of *APOE* $\epsilon 4$ genotype on cognitive functioning therefore remains uncertain. A recent systematic review on the effect of *APOE* $\epsilon 4$ on cognition in the healthy population (O'Donoghue et al., 2018) indeed suggested that cognitive deficits shown by *APOE* $\epsilon 4$ carriers can be partly explained by early AD pathology ('Prodromal hypothesis'; Foster et al., 2013; Smith et al., 1998), yet they also hypothesised that subtle cognitive deficits related to the *APOE* $\epsilon 4$ genotype could be observed already in mid-adulthood when using sensitive cognitive measures ('Phenotype hypothesis'; Fouquet et al., 2014; Greenwood et al., 2005; Parasuraman et al., 2002). Therefore, the evidence supporting the role of *APOE* genotype on cognitive abilities in the healthy population and the translational potential of this line of research remains still limited.

1.1 Episodic and Semantic Memory

Autobiographical memory includes knowledge of specific lived events (episodic memory) and knowledge about general facts or one's personal life circumstances (semantic memory) (for a review, see Fan et al., 2024). While episodic memory entails re-experiencing and recollecting past events that are traceable in time and space (e.g., one's 18th birthday party), semantic memory relates to knowledge acquired through accumulated experiences but detached from its context of acquisition (e.g., Renoult et al., 2019).

When considering research on episodic and semantic memory in *APOE* $\epsilon 4$ carriers, existing research has predominantly been focused on episodic memory (see O'Donoghue et al., 2018; Small et al., 2004; Wisdom et al., 2011). This is presumably because episodic memory deficits are regarded as the early cognitive hallmark of Alzheimer's Disease, where patients are commonly known to be impaired in the recollection of recent episodic events (McKhann et al.,

2011). In a systematic review examining the role of *APOE* $\epsilon 4$ genotype and episodic memory in AD patients, El Haj et al. (2016) indeed observed that most studies reported a significant relationship between *APOE* $\epsilon 4$ and episodic memory decline. The most recent meta-analysis available in the field (Wisdom et al., 2011) confirmed that healthy $\epsilon 4$ carriers perform significantly worse on episodic memory and executive functioning tasks, in line with a previous meta-analysis (Small et al., 2004). Nevertheless, semantic memory has generally received less attention and acknowledgment in the literature, with only a few studies directly looking at *APOE* $\epsilon 4$ carriers.

The distinction between episodic and semantic memory has also been questioned by studies that have documented how these two forms of memory could be interdependent and overlapping in their neural correlates (see Greenberg & Verfaellie, 2010; Irish & Grilli, 2024; Tanguay et al., 2024). Such distinction has also been revisited through evidence involving clinical populations (Buckley et al., 2014; Duval et al., 2012; Irish et al., 2010; Strikwerda-Brown et al., 2019). Currently, semantic memory has been dissociated into personal and general semantics (Renoult et al., 2012, 2019, 2020; see also Strikwerda-Brown et al., 2019), with the former referring to knowledge of one's personal past and the latter indicating factual and culturally shared knowledge (e.g., events happening in the local community or around the world). Personal semantics has been further fractioned into sub-categories involving autobiographical facts, memory for repeated events, and self-knowledge (Melega et al., 2024; Renoult et al., 2012, 2016; Tanguay et al., 2018).

Despite these recent new insights, the role of semantic memory in healthy people at increased genetic risk of developing AD is yet to be clarified. Semantic memory was initially thought to be relatively spared at the earliest stages of the disease, as seen in famous case studies (see Gabrieli et al., 1988; O'Kane et al., 2004; Warrington & McCarthy, 1988) and less sensitive to impairment by age (Nyberg et al., 2003), therefore consolidating the assumption

that semantic memory may not be a sensitive marker for late-onset AD. A line of evidence has however challenged this view (Duff et al., 2020; Hoffman & Morcom, 2018; Verma & Howard, 2011), with cross-sectional studies involving people with Mild Cognitive Impairment (MCI) and AD which documented semantic memory impairments when using verbal fluency tasks (Chasles et al., 2020; Joubert et al., 2010, 2021; Koenig et al., 2007; Storandt, 2008; Taler et al., 2016, 2020). Interestingly, in a study assessing autobiographical narratives in people with MCI and relative controls, Buckley and colleagues (2014) found that personal semantic memory performance appears to be related to beta-amyloid burden after adjusting for age and *APOE* $\epsilon 4$ genotype. In healthy *APOE* $\epsilon 4$ carriers, longitudinal studies looking at semantic memory decline have however reported mixed results (Wilson et al., 2002; Nilsson et al., 2006), therefore raising the question as to whether *APOE* $\epsilon 4$ genotype could influence semantic memory functioning in people who are at increased genetic risk of developing AD.

1.3 Aims of the present review

To our knowledge, no previous systematic review has selectively investigated the impact of *APOE* $\epsilon 4$ on semantic memory in healthy adults. This was the aim of the present study, where we reviewed the available literature to scrutinize studies that reported and compared performance on semantic memory in non-clinical adult populations with and without *APOE* $\epsilon 4$.

2. Methods

The initial search was carried out on 1st March 2024 according to Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines followed by an update search on 1st September 2024, and another one carried out on 1st March 2025. The search protocol and inclusion/exclusion criteria were pre-registered on the Prospero database (ID: CRD42024499684). For this systematic review, we adopted a narrative synthesis approach, as outlined by Popay et al. (2006).

2.1 Search strategy

The search strategy included the electronic databases: Academic Search Complete, AMED (The Allied and Complementary Medicine Database), CINAHL Complete (Cumulative Index of Nursing and Allied Health Literature), APA PsycArticles, APA PsycInfo, and MEDLINE Complete. The following search terms were used: “*APOE*” OR “*apolipoprotein*” AND “*memory*”).

As in previous reviews in the field (O’Donoghue et al., 2018), we only considered papers published from 1993, the year when *APOE* ε4 was first identified as a risk factor for AD (Corder et al., 1993). We also carried out a manual search by looking at reference lists of the articles included, systematic reviews, or meta-analyses relevant to the review topic.

2.2 Inclusion and exclusion criteria

The inclusion criteria were selected using the Population, Intervention, Outcomes and Study (PICOS) framework (Methley et al., 2014; Pollock & Berge, 2018):

- 1) Population: healthy adults over the age of 18 without a diagnosis of neurodegenerative disease (including mild cognitive impairment), acquired brain injuries, psychiatric conditions, or reports of subjective memory complaints or decline;
- 2) Comparison: studies needed to report *APOE* genotype (i.e., $\epsilon 2$, $\epsilon 3$, $\epsilon 4$ or $\epsilon 4$ carriers vs non-carriers), and include a group comparison looking at semantic memory performance between *APOE* $\epsilon 4$ carriers and non-carriers;
- 3) Outcome: Semantic memory performance assessed through standardized neuropsychological, cognitive test, or experimental memory tasks;
- 4) Study: Empirical studies published in the English language.

In this process, we also referred to the following exclusion criteria:

- 1) Studies only including a paediatric population (under the age of 18);
- 2) Animal studies;
- 3) Studies that do not report on semantic memory performance at baseline (e.g., longitudinal study) and/or that do not mention semantic memory;
- 4) Reviews (including systematic reviews), meta-analyses, book chapters, and case reports;
- 5) Studies published in other languages than English;

2.3 Screening and Selection

Relevant articles were screened by title, abstract, and full-text after the removal of duplicates by the first reviewer (R.S.). A second reviewer (T.J.) screened 10% of the articles for the title and abstract and 20% of the articles for full-text. The second reviewer was randomly assigned a selection of articles to screen and was blind to the ratings of the first reviewer (R.S.).

For both stages, the two reviewers discussed and resolved diverging views around inclusion or exclusion of papers.

2.4 Quality Rating

Quality assessment and critical appraisal were carried out on the included studies to evaluate the risk of bias using the Appraisal tool for Cross-Sectional Studies (AXIS – Downes et al., 2016). The AXIS tool includes 20 items with “Yes”, “No” or “Not known” responses looking at the quality of reporting and the study design, and potential sources of bias (See *Appendix C*). The rating of risk of bias (“High”, “Medium” or “Low”) was based on reviewers’ judgment. To aid the quality rating process, a numerical rating was also computed: “Yes” answers received a point, and a “No” or “Not known” answer was scored as zero (excluding items 13 and 19, for which scores were reversed to “Yes/Not known” = 0, “No” = 1).

As in the screening and selection process, the two reviewers completed this step and were blind to the ratings of each other. The second reviewer assessed the quality and risk of bias of approximately 50% of the included papers. Once the quality rating was completed, they discussed and resolved diverging views regarding the quality rating of the articles. The two raters agreed on almost all the items (154/160, 96.25%) and were able to resolve any minor disagreements.

3. Results

3.1 Study selection

Figure 1 shows the review process via the PRISMA 2020 flowchart diagram (see also Appendix B). The initial search from all the databases produced 7,881 articles. A total of 4,683 duplicates were removed, and 3,198 papers were screened via preliminary screening by title and abstract. Forty-eight studies underwent full-text screening.

We excluded 26 research articles during full-text screening.¹ Of the 22 remaining papers, four were excluded as they were longitudinal studies with no baseline data on semantic memory in *APOE* ϵ 4 carriers vs non-carriers, five used data from a cohort already used in previously included studies, and one paper reported data that were not extractable. This left 12 articles, all conventionally identified via databases. Two additional papers were identified via citation-searching of relevant papers, while three other papers were included in a previous systematic review looking at a similar research question (O'Donoghue et al., 2018). Seventeen papers were included, with a total number of 8,491 participants tested.

¹ The 26 records excluded for the following reasons: *APOE* status was not stratified (n = 3), inclusion of postmortem data (n = 1), inclusion of MCI participants (n = 4), cohort used in previous studies (n = 5), involvement of other genetic markers (n = 3), inclusion of dementia/AD patients (n = 2), semantic memory was not the main variable of interest (n = 7), inclusion of participants with subjective memory complaints (n = 1).

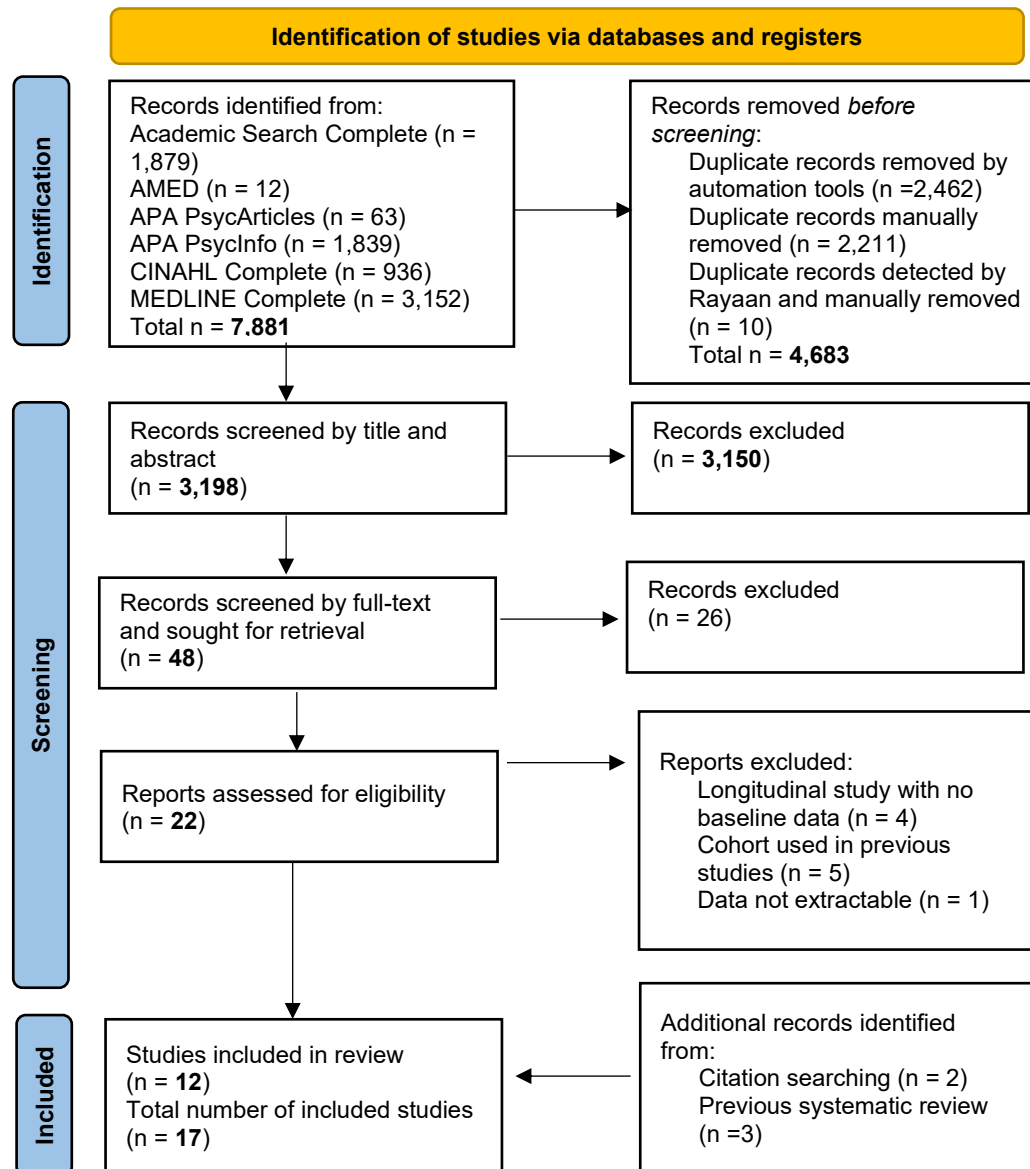


Figure 1. PRISMA flowchart outlining the article identification, screening and selection process.

3.2 Quality Assessment and Risk of Bias

Seven studies were rated as having “Medium” risk of bias, one paper was rated as “Medium to High” risk, and the remaining nine articles were considered to have a “Low” risk. Of the 17 articles, 10 did not justify the sample size nor mentioned power analysis (Item 3).

3.3 Study Details

Detailed characteristics of each of the included studies are reported in *Table 1*. Apart from a single longitudinal study (Nilsson et al., 2006), all were cross-sectional studies looking at group comparisons between *APOE* $\epsilon 4$ carriers and non-carriers at a single time point. One paper (Seidenberg et al., 2009) also grouped the participants by family history for AD and *APOE* genotype to determine risk, while five papers stratified the participants for *APOE* genotype groups (i.e., *APOE* $\epsilon 2/2$, $\epsilon 2/3$, $\epsilon 3/3$, $\epsilon 4/4$, $\epsilon 2/4$, $\epsilon 3/4$; Helkala et al., 1995; Nilsson et al., 2006; Salo et al., 2001; Staehelin et al., 1999; Wikgren et al., 2012). The remaining 11 papers divided their participants between *APOE* $\epsilon 4$ carriers (+) and non-carriers (-).

The study sample sizes varied extensively, from samples of a few dozen participants (e.g., Grilli et al., 2018, 2021; Rosen et al., 2005; Salo et al., 2001) to large cohorts of hundreds or even thousands respondents (e.g., Ford et al., 2020; Helkala et al., 1995; Laukka et al., 2013; Nilsson et al., 2006; Payton et al., 2006) depending on the populations and databases used by the authors. Overall, the sample sizes ranged from 40 to 2694 participants (see *Table 1*).

Likewise, the age groups of the samples included in the studies varied too. All but one study included healthy older adults in their samples (Eich et al., 2019). Out of those 16 studies that included healthy older adults, three papers stratified the age of their participants by Young-Old or Old-Old adults (e.g., < 75 years and > 75 years respectively; Duchek et al., 2006; Nilsson et al., 2006; Stahaelin et al., 1999).

Eight studies also included middle-aged adults (Eich et al., 2019; Grilli et al., 2018, 2021; Knoff et al., 2024; Nilsson et al., 2006; Payton et al., 2006; Rosen et al., 2005; Wikgren et al., 2012) and two studies also provided data from younger adults (Duchek et al., 2006; Eich et al., 2019).

Table 1. Tabulated results of the papers included in the systematic review.

Author, Year	Study type	Sample size	Age groups	<i>APOE</i> groups	Semantic memory Task	Key finding/ <i>APOE</i> $\epsilon 4$ effect
Duchek et al., (2006)	Cross-sectional	n = 76	Healthy Younger adults (18-24 years), Young-old adults (65-78 years), Old-old adults (80-93 years)	<i>APOE</i> $\epsilon 4$ (+) <i>APOE</i> $\epsilon 4$ (-)	Information (WAIS-IV); General Knowledge test (Einstein et al, 1995); Word fluency test S-P (Thurstone & Thurstone, 1949); Boston Naming Test (Kaplan et al., 1983); Animal Naming Test (Goodglass & Kaplan, 1983)	Higher performance on Animal Naming Test in Young-old <i>APOE</i> $\epsilon 4$ (+) ($p = .013$, $d = 1.14$)
Eich et al., (2019)	Cross-sectional	n = 146	Healthy Young and middle-aged adults (20-60 years)	<i>APOE</i> $\epsilon 4$ (+) <i>APOE</i> $\epsilon 4$ (-)	Synonyms and Antonyms (Salthouse, 1993a,b); Picture Naming (Woodcock et al., 1989)	No significant group differences
Ford et al., (2020)	Cross-sectional	n = 699	Healthy older adults (60 -85 years)	<i>APOE</i> $\epsilon 4$ (+) <i>APOE</i> $\epsilon 4$ (-)	Categorization task (Stern & White, 2003)	Lower semantic clustering in <i>APOE</i> $\epsilon 4$ (+) ($p = .015$, $d = 0.22$)

Grilli et al., (2018)	Cross-sectional	n = 40	Healthy middle-aged and older adults (52-80 years)	<i>APOE</i> ε4 (+) <i>APOE</i> ε4 (-)	Verbal Comprehension Index (WAIS-IV); Boston Naming Test; Category Fluency Test; Autobiographical Memory Interview (Levine et al., 2002)	No significant group differences
Grilli et al., (2021)	Cross-sectional	n = 45	Healthy middle-aged and older adults (53 – 84 years)	<i>APOE</i> ε4 (+) <i>APOE</i> ε4 (-)	Verbal Comprehension index (WAIS-IV); Boston Naming Test; Category and Letter Fluency tests (COWAT, Benton, 1969); Autobiographical fluency task (Addis & Tippett, 2004)	<i>APOE</i> ε4 (+) generated fewer exemplars on autobiographical fluency (p = .02, η ² = .13), with lower personal semantic (p = .02, d = .71) and episodic memory fluency (p = .02, d = .64)
Helkala et al., (1995)	Cross-sectional	n = 916	Healthy older adults (> 65)	<i>APOE</i> ε2/2, ε2/3 <i>APOE</i> ε3/3 <i>APOE</i> ε4/4, ε2/4, ε3/4	Category and Letter Fluency tests	No significant group differences
Knoff et al., (2024)	Cross-sectional	n = 84	Healthy middle-aged and older adults (60 – 80 years)	<i>APOE</i> ε4 (+) <i>APOE</i> ε4 (-)	Verbal Comprehension index (WAIS-IV); Boston Naming Test; Category Fluency test	No significant group differences

Laukka et al., (2013)	Cross-sectional	n = 2694	Healthy older adults (60 - 90+ years)	<i>APOE</i> ε4 (+) <i>APOE</i> ε4 (-)	SRB Vocabulary test (Dureman, 1960) General Knowledge task (Dahl et al., 2009)	No significant group differences
Nilsson et al., (2006)	Longitudinal (Betula study)	n = 1733	Middle-aged adults (35-50 years), Young-old adults (55-65 years), Old-old adults (70-85 years)	<i>APOE</i> ε3/3 <i>APOE</i> ε3/4 <i>APOE</i> ε4/4	SRB vocabulary test (Dureman, 1960) Category and Letter fluency tests	No significant group differences
Payton et al., (2006)	Cross-sectional	n = 766	Middle-aged and older adults (50 – 85 years)	<i>APOE</i> ε4 (+) <i>APOE</i> ε4 (-)	Raven Mill Hill vocabulary scale parts A and B (Raven, 1965)	No significant group differences
Rosen et al., (2005)	Cross-sectional	n = 40	Healthy middle-aged and older adults (50–79 years)	<i>APOE</i> ε4 (+) <i>APOE</i> ε4 (-)	Extensive category fluency task (10 minutes); Brief Category and Letter fluency task (both 1-minute); Vocabulary (WAIS-IV)	<i>APOE</i> ε4 (+) generated fewer animal names (p = .02, d = .68), and fewer clusters of semantically related words (p = .03, d = .63) on extensive Category Fluency test and showed longer between-cluster retrieval times (p = .03, d = .62)
Salo et al., (2001)	Cross-sectional	n = 46	Healthy older adults (> 85)	<i>APOE</i> ε2/2,2/3 <i>APOE</i> ε3/3 <i>APOE</i> ε4/4, ε2/4, ε3/4	Category and Letter Fluency tests; Similarities (WAIS-R)	No significant group differences
Sapkota et al., (2016)	Cross-sectional	n = 282	Healthy older adults (> 60 years)	<i>APOE</i> ε4 (+) <i>APOE</i> ε4 (-)	Vocabulary task (Ekstrom et al., 1976)	No significant group differences

Seidenberg et al., (2009)	Cross-sectional	n = 69	Healthy older adults (65-85 years)	Control: No AD family history, <i>APOE</i> $\epsilon 4$ (-) Group 1: AD Family history, <i>APOE</i> $\epsilon 4$ (-) Group 2: AD family history, <i>APOE</i> $\epsilon 4$ (+)	Fame judgement task (Douville et al., 2005).	No significant group differences
Staehelin et al., (1999)	Cross-sectional	n = 332	Healthy older adults (> 65): Young-old (< 75 years) Old -old (> 75 years)	<i>APOE</i> $\epsilon 2/2$, $\epsilon 2/3$, $\epsilon 2/4$ <i>APOE</i> $\epsilon 3/3$ <i>APOE</i> $\epsilon 4/4$, $\epsilon 3/4$	Vocabulary (WAIS-R)	<i>APOE</i> $\epsilon 3$ group > <i>APOE</i> $\epsilon 4$ group ($p=.041$, $d = 0.29$). Trend for <i>APOE</i> $\epsilon 2$ group > <i>APOE</i> $\epsilon 4$ group ($p = .062$, $d = 0.33$)
Tse et al., (2010)	Cross-sectional	n = 96	Healthy Older adults (> 60 years)	<i>APOE</i> $\epsilon 4$ (+) <i>APOE</i> $\epsilon 4$ (-)	Category Fluency Word fluency test S-P (Thurstone & Thurstone, 1949); Information and Similarities (WAIS-IV)	No significant group differences
Wikgren et al., (2012)	Cross-sectional	n = 427	Healthy middle-aged and older adults (41-85 years)	<i>APOE</i> $\epsilon 3/3$ <i>APOE</i> $\epsilon 3/4$ <i>APOE</i> $\epsilon 4/4$	SRB vocabulary test (Dureman & Salde, 1971); Word fluency test	No significant group differences

The main source of heterogeneity among the selected studies derived from the type of test or task used to measure semantic memory. As outlined in *Table 2*, 11 studies adopted verbal fluency tasks (i.e., category and/or letter fluency; Duchek et al., 2006; Ford et al., 2020; Grilli et al., 2018, 2021; Helkala et al., 1995; Knoff et al., 2024; Nilsson et al., 2006; Rosen et al., 2005; Salo et al., 2001; Tse et al., 2010; Wikgren et al., 2012), while five used naming tests (e.g., Boston Naming Test; Duchek et al., 2006; Eich et al., 2019; Grilli et al., 2018, 2021; Knoff et al., 2024) and 15 used tests of language comprehension or general knowledge tests (e.g., verbal comprehension tests; Duchek et al., 2006; Eich et al., 2019; Grilli et al., 2018, 2021; Knoff et al., 2024; Laukka et al., 2013; Nilsson et al., 2006; Payton et al., 2006; Rosen et al., 2005; Salo et al., 2001; Sapkota et al., 2016; Seidenberg et al., 2009; Stahelin et al., 1999; Tse et al., 2010; Wikgren et al., 2012). Two studies assessed semantic memory by looking at autobiographical memory retrieval (Grilli et al., 2018, 2021).

Given this heterogeneity in the methodology and tasks employed that may tap into different aspects of semantic memory as well as other cognitive abilities, we herein separately report the findings by reporting the studies for the type of task used to measure semantic memory.

Table 2. Findings of the selected papers tabulated by task used to measure Semantic Memory

Author, year	Letter and/or Category Fluency (n = 11)	Naming (n = 5)	Language Comprehension/ General Knowledge Tests (n = 15)	Autobiographical Memory (n = 2)	APOE Effect
Duchek et al. (2006)	✓**	✓	✓	—	✓**
Eich et al. (2019)	—	✓	✓	—	—
Ford et al. (2020)	✓*	—	—	—	✓*
Grilli et al. (2018)	✓	✓	✓	✓	—
Grilli et al. (2021)	✓	✓	✓	✓*	✓*
Helkala et al. (1995)	✓	—	—	—	—
Knoff et al., (2024)	✓	✓	✓	—	—
Laukka et al. (2013)	—	—	✓	—	—
Nilsson et al. (2006)	✓	—	✓	—	—
Payton et al. (2006)	—	—	✓	—	—
Rosen et al. (2005)	✓*	—	✓	—	✓*
Salo et al. (2001)	✓	—	✓	—	—
Sapkota et al. (2016)	—	—	✓	—	—
Stahaelin et al., (1999)	—	—	✓*	—	✓*
Seidenberg et al. (2009)	—	—	✓	—	—
Tse et al. (2010)	✓	—	✓	—	—
Wikgren et al. (2012)	✓	—	✓	—	—
Ratio	3/11 (27.3%)	0/5 (0%)	1/15 (6%)	1/2 (50%)	5/17 (29.4%)

*APOE ε4(+) < APOE ε4(-), ** APOE ε4(+) > APOE ε4(-)

3.3.1 Verbal Fluency

Verbal fluency tasks involve naming as many components of a particular semantic category (e.g., animals, fruits, vegetables) or as many words starting with a specific letter (e.g., F,A,S) in a specific time frame (usually one minute). While the former task is named Category or Semantic Fluency, the latter is commonly referred to as Letter or Phonemic Fluency. In these tasks, participants are warned against repeating the same word more than once or generating proper nouns, like names of people or places (e.g., cities, countries, regions).

Tests of verbal fluency primarily assess the ability of accessing and retrieving words and their associations from an internal lexicon (Salthouse, 1991) as well as self-monitoring, and mental flexibility which are commonly referred as Executive Functions (de Frias et al., 2005; Lezak et al., 2008). Such tests are included in cognitive screening tests for cognitive impairment and dementia like the Montreal Cognitive Assessment (MOCA, Nasreddine et al., 2005) or the Addenbrookes Cognitive Examination (ACE-III, Mioshi et al., 2006) and are also used as part of a wider assessment of Executive Functioning (e.g., Delis-Kaplan Executive Functioning Systems – DKEFS; Delis et al., 2001).

Eleven studies included in this review considered verbal fluency tests as assessing semantic memory. Eight studies did not find any significant group differences on these tests (Grilli et al., 2018, 2021; Helkala et al., 1995; Knoff et al., 2024; Nilsson et al., 2006; Salo et al., 2001; Tse et al., 2010; Wikgren et al., 2013) and three reported a significant difference between *APOE* ϵ 4 carriers and non-carriers (Duchek et al., 2006; Ford et al., 2020; Rosen et al., 2005).

Interestingly, Duchek et al. (2006) reported significantly higher performance among Young-Old *APOE* ϵ 4 carriers (65 to 78 years of age) on the Animal Naming Test ($p = .013$, d

= 1.14) compared to non-carriers, therefore showing a reverse effect of the *APOE* $\epsilon 4$ genotype on naming performance. Such reversed effects are not unusual in the field of cognition in *APOE* $\epsilon 4$ genotype, although they are usually observed in early adulthood (see Section 4).

Along with the traditional one-minute Category and Letter fluency tests, Rosen et al. (2005) also administered an extensive Category Fluency task where participants were asked to generate names from the animal category for 10 minutes and were also encouraged to generate names from subcategories (e.g., flowers). Despite not finding any significant differences in the one-minute Category and Letter fluency tests, the authors reported that *APOE* $\epsilon 4$ carriers generated fewer animal names ($p = .02$, $d = .68$), and fewer clusters of semantically related words ($p = .03$, $d = .63$) as compared to non-carriers. These participants also showed longer retrieval times when shifting from one cluster to another when compared to non-carriers ($p = .03$, $d = .63$). The effect sizes for these significant findings ranged from medium to large.

More recently, Ford et al. (2020) assessed the ability of participants to generate groups of semantically similar information using the Categorization task (CAT; Stern & White, 2003) and to group words of similar meaning, measured by the Semantic Clustering index, where a cluster corresponded to two or more words. The CAT task uses visual cues such as photographs and verbal information. While there were no significant differences in the Categorization task, the authors observed a lower Semantic Clustering performance among *APOE* $\epsilon 4$ carriers ($p = .015$, $d = 0.22$) compared to non-carriers, with a small effect size.

Considering the results of the verbal fluency tests together, it appears that *APOE* $\epsilon 4$ carriers' performance on these tasks generally does not differ from the performance of non-carriers. This pattern of results does not seem to be influenced by the age groups of the participants involved, the sample size included in the studies, or the rated risk of bias. However, those studies that employed a more complex variation of the classic verbal fluency tests

reported a lower performance among *APOE* $\epsilon 4$ carriers (Ford et al., 2020; Rosen et al., 2005) despite referring to different age groups and sample sizes. This, therefore, suggests that group differences could emerge with a more sophisticated assessment of verbal fluency that goes beyond the classic one-minute timeframe (Rosen et al., 2005) or that considers semantic clusters (Ford et al., 2020; Rosen et al., 2005) as a measure of semantic memory functioning.

3.3.2 Naming

Naming tests are designed to determine confrontational picture-naming and word retrieval and, more generally, to assess expressive language. For instance, the commonly used Boston Naming Test (Kaplan et al., 1983) requires respondents to name a series of pictures of common line-drawn objects and animals. If an object is not named spontaneously, participants are allowed to receive semantic cues (e.g., “something that contains water” for a glass). Although naming abilities are usually considered part of the language cognitive domain, the ability to recognise and name common objects largely draws upon the use of semantic knowledge and lexicon.

In this review, five studies (Duchek et al., 2006; Eich et al., 2019; Grilli et al., 2018, 2021; Knoff et al., 2024) included naming tests as a proxy measure of semantic memory, such as the Boston Naming Test (Kaplan et al., 1983), and the Picture Naming Test (Woodcock et al., 1989). As all five studies failed to detect any significant group difference (Duchek et al., 2006; Eich et al., 2019; Grilli et al., 2018, 2021; Knoff et al., 2024), when considered all together, these findings suggest that the presence of *APOE* $\epsilon 4$ genotype does not generally seem to impact semantic memory when assessed through common language naming tasks. Crucially, some of these studies also reported the presence of ceiling effects in both carriers

and non-carriers on the Boston Naming task (Duchek et al., 2006; Grilli et al., 2021; Knoff et al., 2024), as could be expected in samples of healthy older adults.

3.3.3 Language Comprehension/General Knowledge Tests

Tests of language comprehension are also informative for semantic memory functioning. For instance, subtests of the Verbal Comprehension Index of the Weschler Adult Intelligence Scale (WAIS-IV; Weschler, 2008) are designed and standardised to assess understanding of language (e.g., Vocabulary), use of verbal reasoning (e.g., Similarities) and of verbal knowledge (e.g., Information), which all rely on semantic knowledge.

Fourteen studies included in this review employed a language comprehension task as a measure of semantic memory performance (Duchek et al., 2006; Eich et al., 2019; Grilli et al., 2018, 2021; Knoff et al., 2024; Laukka et al., 2013; Nilsson et al., 2006; Payton et al., 2006; Rosen et al., 2005; Salo et al., 2001; Sapkota et al., 2016; Stahaelin et al., 1999; Tse et al., 2010; Wikgren et al., 2012). These tasks included the subtests of the Verbal Comprehension index of the WAIS-IV, the SRB Vocabulary Test (Dureman, 1960), its revised version (Dureman & Salde, 1971), Vocabulary tasks (see Ekstrom et al., 1976; Raven 1965), Synonyms and Antonyms (Salthouse 1993a, 1993b).

Thirteen of these studies did not observe a significant group difference in language comprehension tasks (Duchek et al., 2006; Eich et al., 2019; Grilli et al., 2018, 2021; Knoff et al., 2024; Laukka et al., 2013; Nilsson et al., 2006; Payton et al., 2006; Rosen et al., 2005; Salo et al., 2001; Sapkota et al., 2016; Tse et al., 2010; Wikgren et al., 2013). While only Stahaelin et al. (1999) reported a significant effect of *APOE* ϵ 4, whereby carriers performed significantly worse than *APOE* ϵ 3 carriers ($p = .041$, $d = 0.29$) on the Vocabulary test of the WAIS-Revised, with a small effect size. Apart from this single study, the findings reported in the other studies predominantly suggest that, when semantic memory is measured through standard tests of

language comprehension, *APOE* ε4 carriers and non-carriers do not seem to differ on these tasks. Nonetheless, in those studies looking at the Verbal Comprehension Index of the WAIS-IV (Grilli et al., 2018, 2021; Knoff et al., 2024), mean composite scores suggested that participants fell in the high average range (110 to 119) or even in the superior range (120 to 129) of the general population, which indicates these participants were highly educated for their age. This, therefore, may indicate a sampling bias and a non-accurate representation of the general population.

Tests of General Knowledge have also been frequently used as a measure of semantic memory (Bäckmann & Nilsson, 1996; Nyberg et al., 2003). These may include factual questions (“What is the capital of Paraguay?” or “What is the fastest animal in the world?”) or recognition questions, such as identifying the names or pictures of famous people (e.g., historical figures, politicians, actors, singers). In our systematic review, we included three papers using these types of tasks to assess semantic memory. Two studies (Duchek et al., 2006; Laukka et al., 2013) employed a General Knowledge Test (Dahl et al., 2009; Einstein et al., 1995), while Seidenberg et al., (2009) instead used a fame-judgement task, where carrier and non-carrier participants with and without an additional risk factor of a family history were shown a series of names and were asked to rate them as “famous” or as “unfamiliar”. Reportedly, none of these studies observed any significant group differences between *APOE* ε4 carriers and non-carriers on task accuracy or reaction times. There were, however, reports of ceiling effects in Seidenberg et al., (2009), where participants’ performance in all groups exceeded 90% mean accuracy on the fame discrimination task, regardless of their level of genetic risk for developing AD (*APOE* genotype and family history).

3.3.4 Autobiographical Memory

Along with the aforementioned tests, semantic memory can also be measured via interview-based protocols that were developed to measure the retrieval of autobiographical memories. These include the Autobiographical Memory Interview (Kopelman et al., 1989) or the widely used Autobiographical Interview (Levine et al., 2002) and its more recent updated version (see Melega et al., 2024). These tasks are designed to assess and measure episodic and semantic memory retrieval, as they are both considered integrative parts of autobiographical memory.

In our systematic review, only two of the selected studies assessed the effect of *APOE* $\epsilon 4$ allele on semantic memory by considering autobiographical memory (Grilli et al., 2018, 2021). In their first study, Grilli et al. (2018) administered an adapted version of the Autobiographical Interview (Levine et al., 2002) to a group of *APOE* $\epsilon 4$ carriers and non-carriers. In this task, healthy older participants were asked to recall events from six different time periods in their lifespan, and detailed memory for each life event was scored as internal (i.e., episodic) or external (including semantic details). While carriers produced autobiographical memories that were generally reduced in internal details, Grilli et al. (2018) did not observe any significant group difference in external details.

In a more recent study, Grilli et al. (2021) used an adapted version of the Autobiographical fluency tasks (Addis & Tippet, 2004; see also Dritschel et al., 1992) to assess episodic and personal semantic details. In this adapted task, participants were asked to generate exemplars of episodic (i.e., distinct events) or personal semantic (e.g., names of personally relevant people) memories across three distinct life periods (childhood, early adulthood, recent life). Reportedly, *APOE* $\epsilon 4$ carriers generated fewer exemplars on this task than non-carriers ($p = .02$, $\eta^2 = .13$), showing an overall lower fluency on personal semantic memory ($p = .02$, d

= .71) as well as on episodic memory ($p = .02$, $d = .64$), all supported by medium to large effect sizes. Interestingly, *APOE* $\epsilon 4$ carriers were not significantly reduced on general semantic fluency, as measured by standard neuropsychological tests of category fluency (animals, fruits/vegetables, and letters commencing with “F”, “A”, “S”). Based on these findings, the authors suggested that, along with reduced episodic memory, autobiographical memory deficits in *APOE* $\epsilon 4$ carriers could also extend to personal semantics, but not general semantics.

Despite the very limited numbers, studies on autobiographical memory retrieval coherently suggest that the presence of the *APOE* $\epsilon 4$ allele may not impact semantic memory when recollecting life events (Grilli et al., 2018), or at least not all aspects of semantic memory, as it was observed in one study that *APOE* $\epsilon 4$ negatively impacted the generation of personal semantic memory, when it was assessed via the demands of the autobiographical fluency task (Grilli et al., 2021).

4. Discussion

As evidence has suggested that semantic memory could be impaired in MCI and AD (Chasles et al., 2020; Joubert et al., 2010, 2020; Taler et al., 2016, 2020) we aimed to systematically review the available literature that explored the role of *APOE* $\epsilon 4$ genotype on this memory domain in healthy adults at increased genetic risk of developing AD. Research in the field has abundantly reported episodic memory deficits in the presence of *APOE* $\epsilon 4$ genotype (O’Donoghue et al., 2018; Small et al., 2004; Wisdom et al., 2011), while semantic memory has been so far marginally considered.

We overall found broad similarities in performance on tasks of semantic memory between those at risk of AD and those not, with some exceptions. The picture that, however,

emerged from our systematic review is depicted by highly heterogeneous views on how semantic memory has been conceptualised and assessed over the past thirty years of research.

For instance, Nilsson et al. (2006) highlighted a theoretical ambiguity in how to classify verbal fluency tests. These authors crucially stated that when some relevant longitudinal studies in the field were commenced, verbal fluency tests were reliably regarded as tests of semantic memory (Backmann & Nilsson 1996; Nilsson et al., 1997), as they assessed the generation of words from an internal lexicon (Kausler, 1982, 1991), while they later started to be considered as part of a wider executive functioning assessment (de Frias et al., 2005; Salthouse et al., 2003). Similarly, even though naming tasks are often used as a measure of semantic memory, they are also employed as a measure of language production abilities. Even tasks assessing language or word comprehension that are considered more direct measures of semantic memory (Laukka et al., 2013; Nilsson et al., 2006), together with tasks assessing general knowledge of semantic facts (i.e., general semantics), still rely on other cognitive domains such as language and executive functioning. For consistency, we here briefly summarise the results of the effect of *APOE* ϵ 4 genotype for each cognitive task used to assess semantic memory functioning.

When assessed with standard verbal fluency tasks, the studies here reviewed consistently reported similar semantic memory performance between *APOE* ϵ 4 carriers and non-carriers, apart from one study from Duchek et al. (2006), where Young-Old *APOE* ϵ 4 carriers outperformed non-carriers on an Animal Naming task. To date, paradoxical findings are not unusual in this research field (see Carrion-Baralt et al., 2009), as past studies also documented unaffected or even improved cognitive performance in *APOE* ϵ 4 young adult carriers as compared to non-carriers of similar age (Acevedo et al., 2010; Bloss et al., 2010; Mondadori et al., 2007), therefore suggesting that *APOE* ϵ 4 could have a beneficial effect on cognition in early life but a detrimental effect on cognition in later life (Han & Bondi, 2008).

Nonetheless, there is still quite limited longitudinal evidence to support this hypothesis (see Ihle et al., 2012) and a more recent meta-analysis failed to observe any significant differences between young carriers and non-carriers on several cognition domains (see Weissberger et al., 2018).

A significant genotype effect was detected in studies that employed a more complex version of verbal fluency tasks where semantic memory was assessed over longer periods (i.e., 10 minutes, see Rosen et al., 2005). It could be argued that more complex semantic tasks are associated with heavier demands on executive functions (Eich et al., 2010; Rosen et al., 2005) that are known to be affected in $\epsilon 4$ carriers (O'Donoghue et al., 2018; Smith et al., 2004; Wisdom et al., 2011), as observed in early studies investigating semantic memory in AD where patients showed difficulties on semantic tasks that required self-initiation (e.g., category fluency, see Henry et al., 2004; Nebes, 1989). Moreover, studies assessing the ability of grouping words with similar meaning in verbal fluency tasks (i.e., semantic clustering) observed that the *APOE* $\epsilon 4$ genotype was associated with reduced performance (Ford et al., 2020; Rosen et al., 2005), in line with studies that documented a decline in the usage of semantic clustering from MCI to a final diagnosis of AD (Malek-Ahmadi et al., 2011; McLaughlin et al., 2014).

When semantic memory was tested with naming tasks, there were no significant group differences between *APOE* $\epsilon 4$ carriers and non-carriers. Nevertheless, three studies also reported the presence of ceiling effects in the commonly used Boston Naming Task (Duchek et al., 2006; Grilli et al., 2021; Knoff et al., 2024), which could be expected in tasks that were initially designed for clinical populations. This therefore raises the question as to whether these tasks would be appropriate and sensitive enough to assess semantic memory in the healthy adult population, although performance on naming abilities was generally found to decline in late adulthood (see Verhaegen & Poncelet, 2012).

Taken together, when semantic memory is assessed via naming tasks, the evidence in support of the *APOE* $\epsilon 4$ genotype effect remains limited and confined to one single study that reported significantly lower performance in *APOE* $\epsilon 4$ (Staehelin et al., 1999), while the rest of the papers reviewed generally do not indicate any significant group differences between carriers and non-carriers. The study from Staehelin and colleagues not only stratified by participants by specific *APOE* genotype groups but also assessed cognitive performance in different groups of healthy older adults (i.e., Young-Old, Old-Old). Instead, in other studies reporting average scores on Verbal Comprehension Index (Grilli et al., 2018, 2021; Knoff et al., 2024) there was a tendency to include highly educated participants.

Only two studies assessed semantic memory retrieval through autobiographical memory tasks. The study from Grilli et al. (2018) was the first and, so far, the only one adopting the autobiographical memory interview to compare *APOE* $\epsilon 4$ cognitively healthy middle-aged and older carriers and non-carriers. Nonetheless, in the autobiographical interview, external details include general semantics, personal semantics, but also metacognitive statements, comments and repetitions, and details about off-topic events, and are thus not a pure measure of semantic processing, though semantic details often represent an important portion of the interview transcripts, especially in older adults (Renoult et al., 2020). Further studies should clarify whether $\epsilon 4$ carriers and non-carriers differ in semantic details specifically.

The emerging finding of a specific impact on personal semantics, highlighted by Grilli et al. (2021), suggests that personal and general semantic fluency may entail different task demands, whereby personal semantics involve the retrieval of personally known names or spatiotemporal context (i.e., lifetime periods) which also share some episodic qualities (see Renoult et al., 2012) and is supported by the medial temporal lobe (Conway, 2005; Greenberg et al., 2009; Sheldon & Moscovitch, 2012). Similar findings were also found by Buckley et al. (2014), where personal semantic memory performance was related to neocortical beta-amyloid

burden after adjusting for age and *APOE* status. Neuroimaging studies also documented changes in brain anatomy and connectivity in medial temporal lobe regions among healthy *APOE* $\epsilon 4$ carriers (Donix et al., 2010; Gallagher & Koh, 2011; Machulda et al., 2011; Mishra et al., 2018; for reviews see also Habib et al., 2017; Kucikova et al., 2021). Despite the restricted number of studies looking at this, the study from Grilli et al. (2021) demonstrated broader autobiographical memory alterations associated with *APOE* $\epsilon 4$ genotype, which are not solely confined to episodic memory (see Grilli & Verfaellie, 2014).

Considering the overall results of this systematic review, most of the reviewed studies (70%) did not report significant group differences in semantic memory between carriers and non-carriers. These findings are consistent with a previous systematic review that also considered semantic memory (O'Donoghue et al., 2018). In our review, four of the five remaining studies that reported significant group differences reported lower semantic memory performance in *APOE* $\epsilon 4$ carriers (Staehelin et al., 1999; Rosen et al., 2005; Ford et al., 2020; Grilli et al., 2021) and one reported an opposite effect in young participants (Duchek et al., 2006), with effect sizes ranging from small for naming tasks (Staehelin et al., 1999) and medium to large in tasks involving verbal fluency (Rosen et al., 2005; Ford et al., 2020) and autobiographical fluency (Grilli et al., 2021). As such, the evidence reviewed here predominantly suggests that *APOE* $\epsilon 4$ genotype is unlikely to influence semantic memory retrieval, at least when this is measured and assessed via standard neuropsychological tasks (i.e., verbal fluency, naming, and language comprehension tasks). Some group differences emerged when semantic memory was assessed via modified and more complex versions of verbal fluency tasks or when measuring semantic clustering (Rosen et al., 2005; Ford et al., 2020), or when using autobiographical memory tasks allowing to differentiate personal and general semantics (Grilli et al., 2021).

This pattern of results indicates that the effect of *APOE* $\epsilon 4$ genotype on semantic memory could be revealed with a more precise assessment of semantic memory functioning. As observed in studies involving people with amnesia that used more complex semantic tasks (see Duff et al., 2020 for a review), semantic memory deficits could be similar to those of episodic memory as both memory domains rely on medial temporal regions. These tasks could include word associate tests (i.e., identifying synonyms and common collocates), word senses tasks (i.e., name all the senses that a related to a word), and word feature tasks (i.e., name all of the features of a word) (Klooster & Duff, 2015), or extensive naming tasks (Hilveman & Duff, 2021), fairy tales or Bible stories (Rosenbaum et al., 2009; Verfaellie et al., 2014) or even generating hypothetical meaning for novel word compounds (e.g., cactus carpet, see Keane et al., 2020). Moreover, longitudinal evidence also suggested that semantic memory performance effectively declines over time in $\epsilon 4$ carriers, when assessed through a composite score combining verbal fluency with naming, reading and vocabulary abilities (see Wilson et al., 2002).

Considering future research, there is a clear need for more studies adopting measures of autobiographical memory. Such tasks and interview protocols could arguably represent a more ecologically valid assessment of episodic and semantic memory function, which are notionally linked to brain areas that are vulnerable to the early stages of AD pathology (i.e., medial temporal lobes, see Martinelli et al., 2013) as already stated for more complex general semantic tasks (Duff et al., 2020). Therefore, a more precise assessment of semantic memory is needed to better understand whether this cognitive domain is affected by *APOE* $\epsilon 4$ genotype, and studies focusing on autobiographical memory tasks could cast light on this matter.

4.1 Other sources of heterogeneity and limitations

The age of the participants included in the selected papers could have also been a source of heterogeneity and bias in our findings, as most *APOE* $\epsilon 4$ effects on cognition are usually observed in older adults. Out of the 17 papers here reviewed, 16 included healthy older adults (94%), while 8 studies also included middle-aged adults (47%) and two even included younger adults (11.8%). As almost all studies included older adults and only few considered participants in early adulthood, the mediating influence of age on *APOE* $\epsilon 4$ effects on semantic memory is still unclear.

The studies included in this review differed in terms of *APOE* genotype types used to allocate participants into groups, with thirteen studies looking at overall group differences between *APOE* $\epsilon 4$ carriers and non-carriers (Duchek et al., 2006; Eich et al., 2019; Ford et al., 2020; ; Grilli et al., 2018, 2021; Knoff et al., 2024; Laukka et al., 2013; Payton et al., 2006; Rosen et al., 2005; Sapkota et al., 2016; Seidenberg et al., 2009; Tse et al., 2010), while five stratified respondents for each genotype group (Helkala et al., 1995; Nilsson et al., 2006; Staehelin et al., 1999; Salo et al., 2001; Wikgren et al., 2012). By looking at the date of publication of these latter studies, it appears that they were mainly published in the early years of *APOE* genotype research (later 90s/early 2000s) when the $\epsilon 4$ genotype was still being investigated as a potential genetic risk factor for AD. Instead, later research in the field then started to compare samples with homozygote and heterozygote $\epsilon 4$ carriers to groups of participants who were simply considered non-carriers, likely because the evidence around the effect *APOE* $\epsilon 4$ on cognition has become more consolidated. Nonetheless, recruiting an adequate number of *APOE* $\epsilon 4$ homozygote carriers can also be quite challenging, as these participants are quite rare in the general population (see Caselli & Reiman, 2013), so recruitment would therefore require very large samples of participants, usually from already genotyped cohorts.

4.2 Conclusions

Considering recent research advances that have revisited the role of semantic memory in AD, in our study we systematically reviewed studies comparing healthy adult *APOE* $\epsilon 4$ carriers and non-carriers on semantic memory tasks. Our findings indicate a pervasive heterogeneity and a lack of consensus on the conceptualisation and therefore the assessment of semantic memory. When tested via classic neuropsychological tests that mainly assess general semantic memory, the performance *APOE* $\epsilon 4$ carriers did not generally differ from non-carriers. When semantic memory was assessed via modified versions of verbal fluency tasks or considering semantic clustering, carriers were found to be impaired, probably due to increased task demands on semantic memory. Similarly, in one study considering retrieval fluency of autobiographical memories, carriers showed a deficit in the generation of personal semantic information, compared to non-carriers (Grilli et al., 2021).

We conclude that the impact of *APOE* $\epsilon 4$ on semantic memory may be restricted to more demanding tasks, which could constitute a better match to episodic memory tasks for which effects are typically observed (Small et al., 2004; Wisdom et al., 2011). Future studies looking at autobiographical memory retrieval in *APOE* $\epsilon 4$ carriers could provide a more precise and ecologically valid assessment of semantic memory, especially when disentangling between personal and general forms of semantic memory.

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Authors' contributions

This work was ideated by RS, JB and LR. Literature search and evaluation was completed by the first rater (RS) with the help of a second rater (TJ). The first draft was written by RS and all authors critically read and revised the work, and eventually approved the final manuscript.

Declarations

None.

Conflict of interest

The authors of this research project declare no potential conflict of interest related to the research and the publication of this manuscript.

Data availability

No data are available for this study other than the ones reported in this manuscript.

References

- Acevedo, S. F., Piper, B. J., Craytor, M. J., Benice, T. S., Raber, J., 2010. Apolipoprotein E4 and sex affect neurobehavioral performance in primary school children. *Pediatr Res* 67(3), 293-299. <https://doi.org/10.1203/PDR.0b013e3181cb8e68>
- Addis, R.D., Tippett, L., 2004. Memory of myself: Autobiographical memory and identity in Alzheimer's disease. *Memory* 12 (1), 56-74. <https://doi.org/10.1080/09658210244000423>
- Bäckman, L., Nilsson, L. G., 1996. Semantic memory functioning across the adult life span. *Eur Psychol* 1(1), 27-33. <https://doi.org/10.1027/1016-9040.1.1.27>
- Bastin, C., Feyers, D., Jedidi, H., Bahri, M. A., Degueldre, C., Lemaire, C., ... & Salmon, E., 2013. Episodic autobiographical memory in amnesic mild cognitive impairment: What are the neural correlates?. *Hum Brain Mapp* 34(8), 1811-1825. <https://doi.org/10.1002/hbm.22032>
- Blacker, D., Haines, J. L., Rodes, L., Terwedow, H., Go, R. C. P., Harrell, L. E., ... & Tanzi, R., 1997. APOE-4 and age at onset of Alzheimer's disease: the NIMH genetics initiative. *Neurology* 48(1), 139-147. <https://doi.org/10.1212/WNL.48.1.139>
- Bloss, C. S., Delis, D. C., Salmon, D. P., & Bondi, M. W., 2010. APOE genotype is associated with left-handedness and visuospatial skills in children. *Neurobiol Aging* 31(5), 787-795. <https://doi.org/10.1016/j.neurobiolaging.2008.05.021>
- Buckley, R. F., Saling, M. M., Irish, M., Ames, D., Rowe, C. C., Villemagne, V. L., ... Ellis, K. A., 2014. Autobiographical narratives relate to Alzheimer's disease biomarkers in

older adults. Int Psychogeriatr 26(10), 1737-1746.

<https://doi.org/10.1017/S1041610214001136>

Carrión-Baralt, J. R., Meléndez-Cabrero, J., Rodríguez-Ubinas, H., Schmeidler, J., Beerli, M. S., Angelo, G., ... Silverman, J. M., 2009. Impact of APOE ϵ 4 on the cognitive performance of a sample of non-demented Puerto Rican nonagenarians. J Alzheimers Dis 18(3), 533-540. <https://doi.org/10.3233/JAD-2009-1160>

Caselli, R. J., Reiman, E. M., 2012. Characterizing the preclinical stages of Alzheimer's disease and the prospect of presymptomatic intervention. J Alzheimers Dis 33(s1), S405-S416. <https://doi.org/10.3233/JAD-2012-129026>

Chasles, M. J., Tremblay, A., Escudier, F., Lajeunesse, A., Benoit, S., Langlois, R., ... Rouleau, I., 2020. An examination of semantic impairment in amnesic MCI and AD: What can we learn from verbal fluency?. Arch Clin Neuropsych 35(1), 22-30. <https://doi.org/10.1093/arclin/acz018>

Conway, M. A., 2005. Memory and the self. J Memory and Language 53(4), 594-628. <https://doi.org/10.1016/j.jml.2005.08.005>

Corder, E. H., Saunders, A. M., Strittmatter, W. J., Schmechel, D. E., Gaskell, P. C., Small, G., ... Pericak-Vance, M. A., 1993. Gene dose of apolipoprotein E type 4 allele and the risk of Alzheimer's disease in late onset families. Science 261(5123), 921-923. <https://doi.org/10.1126/science.8346443>

Davidson, Y., Gibbons, L., Pritchard, A., Hardicre, J., Wren, J., Stopford, C., ... Mann, D. M., 2006. Apolipoprotein E ϵ 4 allele frequency and age at onset of Alzheimer's disease. Dement Geriatr Cogn, 23(1), 60-66. <https://doi.org/10.1159/000097038>

Donix, M., Burggren, A. C., Suthana, N. A., Siddarth, P., Ekstrom, A. D., Krupa, A. K., ... & Bookheimer, S. Y., 2010. Longitudinal changes in medial temporal cortical thickness in normal subjects with the APOE-4 polymorphism. *Neuroimage* 53(1), 37-43. <https://doi.org/10.1016/j.neuroimage.2010.06.009>

Dritschel, B. H., Williams, J. M. G., Baddeley, A. D., Nimmo-Smith, I., 1992. Autobiographical fluency: A method for the study of personal memory. *Mem Cognition* 20, 133-140. <https://doi.org/10.3758/BF03197162>

Duchek, J. M., Balota, D. A., Cortese, M., 2006. Prospective memory and apolipoprotein E in healthy aging and early stage Alzheimer's disease. *Neuropsychology*, 20(6), 633 –644. <https://doi.org/10.1037/0894-4105.20.6.633>

Duff, M. C., Covington, N. V., Hilverman, C., Cohen, N. J., 2020. Semantic memory and the hippocampus: Revisiting, reaffirming, and extending the reach of their critical relationship. *Front Hum Neurosci* 13, 471. <https://doi.org/10.3389/fnhum.2019.00471>

Dureman, I., 1960,. *SRB: I*. Psykologiförlaget.

Dureman, I., Kebbon, L., Österberg, E., 1971. *A manual to the DS-battery*. Psykologiförlaget.

Duval, C., Desgranges, B., de La Sayette, V., Belliard, S., Eustache, F., Piolino, P. , 2012. What happens to personal identity when semantic knowledge degrades? A study of the self and autobiographical memory in semantic dementia. *Neuropsychologia* 50(2), 254-265. <https://doi.org/10.1016/j.neuropsychologia.2011.11.019>

de Frias, C. M., Annerbrink, K., Westberg, L., Eriksson, E., Adolfsson, R., Nilsson, L.-G., 2005. Catechol O-Methyltransferase Val158 Met polymorphism is associated with

cognitive performance in nondemented adults. *J Cognitive Neuroscience* 17, 1018–1025.
<https://doi.org/10.1162/0898929054475136>

Delis, D. C., Kaplan, E., Kramer, J. H., 2001. *Delis-Kaplan Executive Function System (D-KEFS)*. APA PsycTests. <https://doi.org/10.1037/t15082-000>

Downes, M. J., Brennan, M. L., Williams, H. C., Dean, R. S., 2016. Development of a critical appraisal tool to assess the quality of cross-sectional studies (AXIS). *BMJ Open* 6(12), e011458. <https://doi.org/10.1136/bmjopen-2016-011458>

Duchek, J. M., Balota, D. A., Cortese, M., 2006. Prospective memory and apolipoprotein E in healthy aging and early stage Alzheimer's disease. *Neuropsychology* 20(6), 633–644. <https://doi.org/10.1037/0894-4105.20.6.633>

Duval, C., Desgranges, B., de La Sayette, V., Belliard, S., Eustache, F., Piolino, P., 2012. What happens to personal identity when semantic knowledge degrades? A study of the self and autobiographical memory in semantic dementia. *Neuropsychologia* 50(2), 254-265.
<https://doi.org/10.1016/j.neuropsychologia.2011.11.019>

El Haj, M., Antoine, P., Amouyel, P., Lambert, J. C., Pasquier, F., Kapogiannis, D., 2016. Apolipoprotein E (APOE) ϵ 4 and episodic memory decline in Alzheimer's disease: A review. *Ageing Res Rev* 27, 15-22. <https://doi.org/10.1016/j.arr.2016.02.002>

Eich, T. S., Tsapanou, A., Stern, Y., 2019. When time's arrow doesn't bend: APOE- ϵ 4 influences episodic memory before old age. *Neuropsychologia* 133, 107180.
<https://doi.org/10.1016/j.neuropsychologia.2019.107180>

Ekstrom, R.B., French, J.E.W., Harman, H.H., Dermen, D., 1976. *Manual for the Kit of Factor-Referenced Cognitive Tests*. Educational Testing Service.

Fan, C., Simpson, S., Sokolowski, H. M., Levine, B., 2024. Autobiographical memory, in: Kahana, M.K., Wagner, K.D. (Eds.), *The Oxford Handbook of Human Memory*, Two Volume Pack: Foundations and Applications. Oxford Academic, Oxford, pp. 1140–1170. <https://doi.org/10.1093/oxfordhb/9780190917982.013.39>

Farrer, L. A., Cupples, L. A., Haines, J. L., Hyman, B., Kukull, W. A., Mayeux, R., ... Van Duijn, C. M., 1997. Effects of age, sex, and ethnicity on the association between apolipoprotein E genotype and Alzheimer disease: a meta-analysis. *JAMA* 278(16), 1349-1356. <https://doi:10.1001/jama.1997.03550160069041>

Faul, F., Erdfelder, E., Buchner, A., Lang, A. G., 2009. Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behav Res Methods* 41(4), 1149-1160. <https://doi.org/10.3758/BRM.41.4.1149>

Ford, J., Zheng, B., Hurtado, B., de Jager, C. A., Udeh-Momoh, C., Middleton, L., Price, G., 2020. Strategy or symptom: Semantic clustering and risk of Alzheimer's disease-related impairment. *J Clin Exp Neuropsych* 42(8), 849-856. <https://doi.org/10.1080/13803395.2020.1819964>

Fortea, J., Pegueroles, J., Alcolea, D., Belbin, O., Dols-Icardo, O., Vaqué-Alcázar, L., ... Montal, V., 2024. APOE4 homozygosity represents a distinct genetic form of Alzheimer's disease. *Nat Med* 30, 1284–1291 (2024). <https://doi.org/10.1038/s41591-024-02931-w>

Foster, J. K., Albrecht, M. A., Savage, G., Lautenschlager, N. T., Ellis, K. A., Maruff, P., ... AIBL Research Group, 2013. Lack of reliable evidence for a distinctive $\epsilon 4$ - related cognitive phenotype that is independent from clinical diagnostic status: findings from the Australian Imaging, Biomarkers and Lifestyle Study. *Brain* 136(7), 2201-2216. <https://doi.org/10.1093/brain/awt127>

Fouquet, M., Besson, F. L., Gonneaud, J., La Joie, R., Chételat, G., 2014. Imaging brain effects of APOE4 in cognitively normal individuals across the lifespan. *Neuropsychol Rev* 24, 290-299. <https://doi.org/10.1007/s11065-014-9263-8>

Gabrieli, J. D., Cohen, N. J., Corkin, S., 1988. The impaired learning of semantic knowledge following bilateral medial temporal-lobe resection. *Brain Cognition* 7(2), 157-177. [https://doi.org/10.1016/0278-2626\(88\)90027-9](https://doi.org/10.1016/0278-2626(88)90027-9)

Gallagher, M., & Koh, M. T., 2011. Episodic memory on the path to Alzheimer's disease. *Curr Opin Neurobiol* 21(6), 929-934. <https://doi.org/10.1016/j.conb.2011.10.021>

Gamboz, N., De Vito, S., Brandimonte, M. A., Pappalardo, S., Galeone, F., Iavarone, A., Della Sala, S., 2010. Episodic future thinking in amnesic mild cognitive impairment. *Neuropsychologia* 48(7), 2091-2097. <https://doi.org/10.1016/j.neuropsychologia.2010.03.030>

Greenberg, D. L., Keane, M. M., Ryan, L., Verfaellie, M., 2009. Impaired category fluency in medial temporal lobe amnesia: The role of episodic memory. *J Neurosci* 29(35), 10900-10908. <https://doi.org/10.1523/JNEUROSCI.1202-09.2009>

Greenberg, D. L., Verfaellie, M., 2010. Interdependence of episodic and semantic memory: Evidence from neuropsychology. *J Int Neuropsych Soc* 16(5), 748-753. <https://doi.org/10.1017/S1355617710000676>

Greenwood, P. M., Sunderland, T., Putnam, K., Levy, J., Parasuraman, R., 2005. Scaling of visuospatial attention undergoes differential longitudinal change as a function of APOE genotype prior to old age: results from the NIMH BIOCARD study. *Neuropsychology* 19(6), 830–840. <https://doi.org/10.1037/0894-4105.19.6.830>

Grilli, M. D., Verfaellie, M., 2014. Personal semantic memory: insights from neuropsychological research on amnesia. *Neuropsychologia* 61, 56-64. <https://doi.org/10.1016/j.neuropsychologia.2014.06.012>

Grilli, M. D., Wank, A. A., Bercel, J. J., Ryan, L., 2018. Evidence for reduced autobiographical memory episodic specificity in cognitively normal middle-aged and older individuals at increased risk for Alzheimer's disease dementia. *J Int Neuropsych Soc* 24(10), 1073-1083. <https://doi.org/10.1017/S1355617718000577>

Grilli, M. D., Wank, A. A., Huentelman, M. J., Ryan, L., 2021. Autobiographical memory fluency reductions in cognitively unimpaired middle-aged and older adults at increased risk for Alzheimer's disease dementia. *J Int Neuropsych Soc* 27(9), 905-915. <https://doi.org/10.1017/S1355617720001319>

Habib, M., Mak, E., Gabel, S., Su, L., Williams, G., Waldman, A., ... & O'Brien, J. T., 2017. Functional neuroimaging findings in healthy middle-aged adults at risk of Alzheimer's disease. *Ageing Res Rev* 36, 88-104. <https://doi.org/10.1016/j.arr.2017.03.004>

Han, S. D., Bondi, M. W., 2008. Revision of the apolipoprotein E compensatory mechanism recruitment hypothesis. *Alzheimers Dement* 4(4), 251-254. <https://doi.org/10.1016/j.jalz.2008.02.006>

Helkala, E. L., Koivisto, K., Hänninen, T., Vanhanen, M., Kervinen, K., Kuusisto, J., ... Riekkinen Sr, P., 1995. The association of apolipoprotein E polymorphism with memory: a population based study. *Neurosci Lett* 191(3), 141-144. [https://doi.org/10.1016/0304-3940\(95\)11575-H](https://doi.org/10.1016/0304-3940(95)11575-H)

Henry, J. D., Crawford, J. R., Phillips, L. H., 2004. Verbal fluency performance in dementia of the Alzheimer's type: a meta-analysis. *Neuropsychologia* 42(9), 1212-1222. <https://doi.org/10.1016/j.neuropsychologia.2004.02.001>

Hilveman, C., Duff, M. C., 2021. Evidence of impaired naming in patients with hippocampal amnesia. *Hippocampus* 31(6), 612-626. <https://doi.org/10.1002/hipo.23325>

Hoffman, P., Morcom, A. M., 2018. Age-related changes in the neural networks supporting semantic cognition: A meta-analysis of 47 functional neuroimaging studies. *Neurosci Biobehav R* 84, 134-150. <https://doi.org/10.1016/j.neubiorev.2017.11.010>

Ihle, A., Bunce, D., Kliegel, M., 2012. APOE ϵ 4 and cognitive function in early life: a meta-analysis. *Neuropsychology* 26(3), 267-277. <https://doi.org/10.1037/a0026769>

Irish, M., Lawlor, B. A., O'Mara, S. M., Coen, R. F., 2010. Exploring the recollective experience during autobiographical memory retrieval in amnesic mild cognitive impairment. *J Int Neuropsych Soc* 16(3), 546-555. <https://doi:10.1017/S1355617710000172>

Irish, M., Lawlor, B. A., O'Mara, S. M., Coen, R. F., 2011. Impaired capacity for auto-noetic reliving during autobiographical event recall in mild Alzheimer's disease. *Cortex* 47(2), 236-249. <https://doi.org/10.1016/j.cortex.2010.01.002>

Irish, M., Addis, D. R., Hodges, J. R., Piguet, O., 2012. Considering the role of semantic memory in episodic future thinking: evidence from semantic dementia. *Brain* 135(7), 2178-2191. <https://doi.org/10.1093/brain/aws119>

Irish, M., Grilli, M. D., 2024. Interactions between episodic and semantic memory, in: Wixted, J.T. (Ed.), *Learning and Memory: A Comprehensive Reference*, Elsevier, pp 1-19. <https://doi.org/10.1016/B978-0-443-15754-7.00009-2>

Jansen, W. J., Ossenkoppele, R., Knol, D. L., Tijms, B. M., Scheltens, P., Verhey, F. R., ... & Amyloid Biomarker Study Group., 2015. Prevalence of cerebral amyloid pathology in

persons without dementia: a meta-analysis. JAMA 313(19), 1924-1938.
<https://doi.org/10.1001/jama.2015.4668>

Joubert, S., Brambati, S. M., Ansado, J., Barbeau, E. J., Felician, O., Didic, M., ... Kergoat, M. J., 2010. The cognitive and neural expression of semantic memory impairment in mild cognitive impairment and early Alzheimer's disease. Neuropsychologia 48(4), 978-988.
<https://doi.org/10.1016/j.neuropsychologia.2009.11.019>

Joubert, S., Gardy, L., Didic, M., Rouleau, I., Barbeau, E. J., 2021. A meta-analysis of semantic memory in mild cognitive impairment. Neuropsych Rev 31, 221-232.
<https://doi.org/10.1007/s11065-020-09453-5>

Kaplan, E., Goodglass, H., & Weintraub, S., 1983. Boston Naming Test (BNT). APA PsycTests. <https://doi.org/10.1037/t27208-000>

Kausler, D. H., 1982. Experimental psychology and human aging. Wiley, New York.

Kausler, D. H., 1991. Experimental psychology, cognition, and human aging. Springer-Verlag, Berlin.

Keane, M. M., Bousquet, K., Wank, A., Verfaellie, M., 2020. Relational processing in the semantic domain is impaired in medial temporal lobe amnesia. J Neuropsych 14(3), 416-430. <https://doi.org/10.1111/jnp.12196>

Klooster, N. B., Duff, M. C., 2015. Remote semantic memory is impoverished in hippocampal amnesia. Neuropsychologia 79, 42-52.
<https://doi.org/10.1016/j.neuropsychologia.2015.10.017>

Knoff, A. A., Bowles, B., Andrews-Hanna, J. R., Grilli, M. D. 2024. Direct access to specific autobiographical memories is lower in healthy middle-aged to older adult

Apolipoprotein E ϵ 4 carriers compared to non-carriers. *J Neuropsychol.*
<https://doi.org/10.1111/jnp.12380>

Koenig, P., Smith, E. E., Moore, P., Glosser, G., Grossman, M., 2007. Categorization of novel animals by patients with Alzheimer's disease and corticobasal degeneration. *Neuropsychology* 21(2), 193–206. <https://doi.org/10.1037/0894-4105.21.2.193>

Kopelman, M. D., Wilson, B. A., Baddeley, A. D., 1989. The autobiographical memory interview: a new assessment of autobiographical and personal semantic memory in amnesic patients. *J Clin Exp Neuropsych* 11(5), 724-744. <https://doi.org/10.1080/01688638908400928>

Kucikova, L., Goerdten, J., Dounavi, M. E., Mak, E., Su, L., Waldman, A. D., ... & Ritchie, C. W., 2021. Resting-state brain connectivity in healthy young and middle-aged adults at risk of progressive Alzheimer's disease. *Neurosci Biobehav R* 129, 142-153.
<https://doi.org/10.1016/j.neubiorev.2021.07.024>

Laukka, E. J., Lövdén, M., Herlitz, A., Karlsson, S., Ferencz, B., Pantzar, A., ... & Bäckman, L., 2013. Genetic effects on old-age cognitive functioning: a population-based study. *Psychol Aging* 28(1), 262–274. <https://doi.org/10.1037/a0030829>

Levine, B., Svoboda, E., Hay, J. F., Winocur, G., Moscovitch, M., 2002. Aging and autobiographical memory: dissociating episodic from semantic retrieval. *Psychol Aging* 17(4), 677–689. <https://doi.org/10.1037/0882-7974.17.4.677>

Lezak, M. D., Howieson, D.B., Bigler, E.D., Tranel, D., 2012. *Neuropsychological Assessment*, fifth ed., Oxford University Press, Oxford.

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., ... & Moher, D., 2009. The PRISMA statement for reporting systematic reviews and meta-

analyses of studies that evaluate health care interventions: explanation and elaboration. *Ann Intern Med* 151(4), W-65.

Liu, C. C., Kanekiyo, T., Xu, H., Bu, G., 2013. Apolipoprotein E and Alzheimer disease: risk, mechanisms and therapy. *Nat Rev Neurol* 9(2), 106-118.
<https://doi.org/10.1038/nrneurol.2012.263>

Machulda, M. M., Jones, D. T., Vemuri, P., McDade, E., Avula, R., Przybelski, S., ... & Jack, C. R., 2011. Effect of APOE ϵ 4 status on intrinsic network connectivity in cognitively normal elderly subjects. *Arch Neurol* 68(9), 1131-1136.
<https://doi.org/10.1001/archneurol.2011.108>

Malek-Ahmadi, M., Raj, A., Small, B. J., 2011. Semantic clustering as a neuropsychological predictor for amnesic-MCI. *Aging Neuropsychol C* 18(3), 280-292.
<https://doi.org/10.1080/13825585.2010.540642>

Martinelli, P., Sperduti, M., Piolino, P., 2013. Neural substrates of the self-memory system: New insights from a meta-analysis. *Hum Brain Mapp* 34(7), 1515-1529.
<https://doi.org/10.1002/hbm.22008>

McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B. T., Jack Jr, C. R., Kawas, C. H., ... Phelps, C. H., 2011. The diagnosis of dementia due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimers Dement* 7(3), 263-269.
<https://doi.org/10.1016/j.jalz.2011.03.005>

McLaughlin, P. M., Wright, M. J., LaRocca, M., Nguyen, P. T., Teng, E., Apostolova, L. G., ... Woo, E., 2014. The "Alzheimer's type" profile of semantic clustering in amnesic mild cognitive impairment. *J Int Neuropsych Soc* 20(4), 402-412.
<https://doi.org/10.1017/S135561771400006X>

Melega, G., Lancelotte, F., Johnen, A. K., Hornberger, M., Levine, B., Renoult, L., 2024. Evoking episodic and semantic details with instructional manipulation during autobiographical recall. *Psychol Aging* 39(4), 378-390. <https://doi.org/10.1037/pag0000821>

Methley, A. M., Campbell, S., Chew-Graham, C., McNally, R., Cheraghi-Sohi, S., 2014. PICO, PICOS and SPIDER: a comparison study of specificity and sensitivity in three search tools for qualitative systematic reviews. *BMC Health Serv Res* 14(1), 1-10. <https://doi.org/10.1186/s12913-014-0579-0>

Mioshi, E., Dawson, K., Mitchell, J., Arnold, R., Hodges, J. R., 2006. The Addenbrooke's Cognitive Examination Revised (ACE-R): a brief cognitive test battery for dementia screening. *Int J Geriatric Psych* 21(11), 1078-1085. <https://doi.org/10.1002/gps.1610>

Mishra, S., Blazey, T. M., Holtzman, D. M., Cruchaga, C., Su, Y., Morris, J. C., ... & Gordon, B. A., 2018. Longitudinal brain imaging in preclinical Alzheimer disease: impact of APOE ϵ 4 genotype. *Brain* 141(6), 1828-1839. <https://doi.org/10.1093/brain/awy103>

Mondadori, C. R., de Quervain, D. J. F., Buchmann, A., Mustovic, H., Wollmer, M. A., Schmidt, C. F., ... Henke, K., 2007. Better memory and neural efficiency in young apolipoprotein E ϵ 4 carriers. *Cereb Cortex* 17(8), 1934-1947. <https://doi.org/10.1093/cercor/bhl103>

Murphy, K. J., Troyer, A. K., Levine, B., Moscovitch, M., 2008. Episodic, but not semantic, autobiographical memory is reduced in amnesic mild cognitive impairment. *Neuropsychologia* 46(13), 3116-3123. <https://doi.org/10.1016/j.neuropsychologia.2008.07.004>

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., ... Chertkow, H., 2005. The Montreal Cognitive Assessment, MoCA: a brief screening tool

for mild cognitive impairment. J Am Geriatr Soc 53(4), 695-699.
<https://doi.org/10.1111/j.1532-5415.2005.53221.x>

Nebes, R. D., 1989. Semantic memory in Alzheimer's disease. Psychol Bull 106(3), 377-394. <https://doi.org/10.1037/0033-2909.106.3.377>

Nilsson, L. G., Bäckman, L., Erngrund, K., Nyberg, L., Adolfsson, R., Bucht, G., ... Winblad, B., 1997. The Betula prospective cohort study: Memory, health, and aging. Aging Neuropsychol C 4(1), 1-32. <https://doi.org/10.1080/13825589708256633>

Nilsson, L. G., Adolfsson, R., Bäckman, L., Cruys, M., Nyberg, L., Small, B. J., Van Broeckoven, C., 2006. The influence of APOE status on episodic and semantic memory: data from a population-based study. Neuropsychology 20(6), 645-657.
<https://doi.org/10.1037/0894-4105.20.6.645>

Nyberg, L., Sandblom, J., Jones, S., Neely, A. S., Petersson, K. M., Ingvar, M., Bäckman, L., 2003. Neural correlates of training-related memory improvement in adulthood and aging. P Natl A Sci 100(23), 13728-13733. <https://doi.org/10.1073/pnas.1735487100>

O'Donoghue, M. C., Murphy, S. E., Zamboni, G., Nobre, A. C., Mackay, C. E., 2018. APOE genotype and cognition in healthy individuals at risk of Alzheimer's disease: A review. Cortex 104, 103-123. <https://doi.org/10.1016/j.cortex.2018.03.025>

O'Kane, G., Kensinger, E. A., Corkin, S., 2004. Evidence for semantic learning in profound amnesia: an investigation with patient HM. Hippocampus 14(4), 417-425.

Parasuraman, R., Greenwood, P. M., Sunderland, T., 2002. The apolipoprotein E gene, attention, and brain function. Neuropsychology 16(2), 254-274. <https://doi.org/10.1037/0894-4105.16.2.254>

Payton, A., Van Den Boogerd, E., Davidson, Y., Gibbons, L., Ollier, W., Rabbitt, P., ... Pendleton, N., 2006. Influence and interactions of cathepsin D, HLA-DRB1 and APOE on cognitive abilities in an older non-demented population. *Genes Brain and Behav* 5(S1), 23-31. <https://doi.org/10.1111/j.1601-183X.2006.00191.x>

Pollock, A., Berge, E., 2018. How to do a systematic review. *Int J Stroke* 13(2), 138-156. <https://doi.org/10.1177/1747493017743796>

Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., Britten, N., Roen, K., Duffy, S., 2006. Guidance on the conduct of narrative synthesis in systematic reviews. ESRC Methods Programme. <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=ed8b23836338f6fdea0cc55e161b0fc5805f9e27>

Raven, J.C., 1965. The Mill Hill Vocabulary Scale. H.K. Lewis, London.

Reiman, E. M., Arboleda-Velasquez, J. F., Quiroz, Y. T., Huentelman, M. J., Beach, T. G., Caselli, R. J., ... Jun, G. R., 2020. Exceptionally low likelihood of Alzheimer's dementia in APOE2 homozygotes from a 5,000-person neuropathological study. *Nat Commun* 11(1), 667. <https://doi.org/10.1038/s41467-019-14279-8>

Renoult, L., Davidson, P. S., Palombo, D. J., Moscovitch, M., Levine, B., 2012. Personal semantics: at the crossroads of semantic and episodic memory. *Trends Cogn Sci* 16(11), 550-558. <https://doi.org/10.1016/j.tics.2012.09.003>

Renoult, L., Tanguay, A., Beaudry, M., Tavakoli, P., Rabipour, S., Campbell, K., ... Davidson, P. S., 2016. Personal semantics: Is it distinct from episodic and semantic memory? An electrophysiological study of memory for autobiographical facts and repeated events in honor of Shlomo Bentin. *Neuropsychologia* 83, 242-256. <https://doi.org/10.1016/j.neuropsychologia.2015.08.013>

Renoult, L., Irish, M., Moscovitch, M., Rugg, M. D., 2019. From knowing to remembering: the semantic–episodic distinction. *Trends Cogn Sci* 23(12), 1041-1057. <https://10.1016/j.tics.2019.09.008>

Renoult, L., Armson, M. J., Diamond, N. B., Fan, C. L., Jeyakumar, N., Levesque, L., ... Levine, B., 2020. Classification of general and personal semantic details in the Autobiographical Interview. *Neuropsychologia* 144, 107501. <https://doi.org/10.1016/j.neuropsychologia.2020.107501>

Rosen, V. M., Sunderland, T., Levy, J., Harwell, A., McGee, L., Hammond, C., ... Lefkowitz, C., 2005. Apolipoprotein E and category fluency: evidence for reduced semantic access in healthy normal controls at risk for developing Alzheimer's disease. *Neuropsychologia* 43(4), 647-658. <https://doi.org/10.1016/j.neuropsychologia.2004.06.022>

Rosenbaum, R. S., Gilboa, A., Levine, B., Winocur, G., Moscovitch, M., 2009. Amnesia as an impairment of detail generation and binding: evidence from personal, fictional, and semantic narratives in KC. *Neuropsychologia* 47(11), 2181-2187. <https://doi.org/10.1016/j.neuropsychologia.2008.11.028>

Salo, A., Ylikoski, R., Verkkoniemi, A., Polvikoski, T., Juva, K., Rastas, S., ... Sulkava, R., 2001. Does apolipoprotein E influence learning and memory in the nondemented oldest old?. *Int Psychogeriatr* 13(4), 451-459. <https://doi.org/10.1017/S1041610201007864>

Salthouse, T. A., 1991. *Theoretical perspectives on cognitive aging*. Erlbaum, Hillsdale, New Jersey.

Salthouse, T. A., 1993. Speed and knowledge as determinants of adult age differences in verbal tasks. *J Gerontol* 48(1), 29-36. <https://doi.org/10.1093/geronj/48.1.P29>

Salthouse, T. A., 1993. Speed mediation of adult age differences in cognition. *Dev Psychol* 29(4), 722–738. <https://doi.org/10.1037/0012-1649.29.4.722>

Salthouse, T. A., Atkinson, T. M., Berish, D. E., 2003. Executive functioning as a potential mediator of age-related cognitive decline in normal adults. *J Exp Psychol Gen* 132(4), 566-594. <https://doi.org/10.1037/0096-3445.132.4.566>

Sheldon, S., Moscovitch, M., 2012. The nature and time-course of medial temporal lobe contributions to semantic retrieval: An fMRI study on verbal fluency. *Hippocampus* 22(6), 1451-1466. <https://doi.org/10.1002/hipo.20985>

Small, B. J., Rosnick, C. B., Fratiglioni, L., Bäckman, L., 2004. Apolipoprotein E and cognitive performance: a meta-analysis. *Psychol Aging* 19(4), 592-600. <https://doi.org/10.1037/0882-7974.19.4.592>

Smith, G. E., Bohac, D. L., Waring, S. C., Kokmen, E., Tangalos, E. G., Ivnik, R. J., Petersen, R. C., 1998. Apolipoprotein E genotype influences cognitive ‘phenotype’ in patients with Alzheimer's disease but not in healthy control subjects. *Neurology* 50(2), 355-362. <https://doi.org/10.1212/WNL.50.2.35>

Staehelin, H. B., Perrig-Chiello, P., Mittrache, C., Miserez, A. R., Perrig, W. J., 1999. Apolipoprotein E genotypes and cognitive functions in healthy elderly persons. *Acta Neurol Scand* 100(1), 53-60. <https://doi.org/10.1111/j.1600-0404.1999.tb00723.x>

Stern, R. A., White, T., 2003. NAB, neuropsychological assessment battery: Administration, scoring, and interpretation manual. Psychological Assessment Resources.

Storandt, M., 2008. Cognitive deficits in the early stages of Alzheimer's disease. *Curr Dir Psychol Sci* 17(3), 198-202. <https://doi.org/10.1111/j.1467-8721.2008.00574.x>

Strikwerda-Brown, C., Mothakunnel, A., Hodges, J. R., Piguet, O., Irish, M., 2019. External details revisited—A new taxonomy for coding ‘non-episodic’ content during autobiographical memory retrieval. *J Neuropsychol* 13(3), 371-397. <https://doi.org/10.1111/jnp.12160>

Suri, S., Heise, V., Trachtenberg, A. J., Mackay, C. E., 2013. The forgotten APOE allele: a review of the evidence and suggested mechanisms for the protective effect of APOE ε2. *Neurosci Biobehav R* 37(10), 2878-2886. <https://doi.org/10.1016/j.neubiorev.2013.10.010>

Taler, V., Voronchikhina, A., Gorfine, G., & Lukasik, M., 2016. Knowledge of semantic features in mild cognitive impairment. *J Neurolinguist* 38, 56-70. <https://doi.org/10.1016/j.jneuroling.2015.11.002>

Taler, V., Monetta, L., Sheppard, C., & Ohman, A., 2020. Semantic function in mild cognitive impairment. *Front Psychol* 10, 3041. <https://doi.org/10.3389/fpsyg.2019.03041>

Tanguay, A. N., Benton, L., Romio, L., Sievers, C., Davidson, P. S., Renoult, L., 2018. The ERP correlates of self-knowledge: Are assessments of one’s past, present, and future traits closer to semantic or episodic memory?. *Neuropsychologia* 110, 65-83. <https://doi.org/10.1016/j.neuropsychologia.2017.10.024>

Tanguay, A., Thériault, K., Clough, S., Taler, V., Renoult, L., Davidson, P., 2024. *The Properties of Personal Semantics*. PsyArXiv. <https://osf.io/preprints/psyarxiv/3d8m7>

Tramoni, E., Felician, O., Koric, L., Balzamo, M., Joubert, S., Ceccaldi, M., 2012. Alteration of autobiographical memory in amnesic mild cognitive impairment. *Cortex* 48(10), 1310-1319. <https://doi.org/10.1016/j.cortex.2011.09.002>

Tse, C. S., Balota, D. A., Moynan, S. C., Duchek, J. M., Jacoby, L. L., 2010. The utility of placing recollection in opposition to familiarity in early discrimination of healthy aging and

very mild dementia of the Alzheimer's type. *Neuropsychology* 24(1), 49 – 67. <https://doi.org/10.1037/a0014887>

Verfaellie, M., Bousquet, K., Keane, M. M., 2014. Medial temporal and neocortical contributions to remote memory for semantic narratives: evidence from amnesia. *Neuropsychologia* 61, 105-112. <https://doi.org/10.1016/j.neuropsychologia.2014.06.018>

Verhaegen, C., Poncelet, M., 2013. Changes in naming and semantic abilities with aging from 50 to 90 years. *J Int Neuropsych Soc* 19(2), 119-126. <https://doi.org/10.1017/S1355617712001178>

Verma, M., Howard, R. J., 2012. Semantic memory and language dysfunction in early Alzheimer's disease: a review. *Int J Geriatr Psych* 27(12), 1209-1217. <https://doi.org/10.1002/gps.3766>

Warrington, E. K., McCarthy, R. A., 1988. The fractionation of retrograde amnesia. *Brain Cognition* 7(2), 184-200. [https://doi.org/10.1016/0278-2626\(88\)90029-2](https://doi.org/10.1016/0278-2626(88)90029-2)

Wechsler, D., 2008. WAIS-IV Manual. Psychological Corporation.

Weissberger, G. H., Nation, D. A., Nguyen, C. P., Bondi, M. W., Han, S. D., 2018. Meta-analysis of cognitive ability differences by apolipoprotein e genotype in young humans. *Neurosci Biobehav R* 94, 49-58. <https://doi.org/10.1016/j.neubiorev.2018.08.009>

Wikgren, M., Karlsson, T., Nilbrink, T., Nordfjäll, K., Hultdin, J., Slegers, K., ... Norrback, K. F., 2012. APOE ϵ 4 is associated with longer telomeres, and longer telomeres among ϵ 4 carriers predicts worse episodic memory. *Neurobiol Aging* 33(2), 335-344. <https://doi.org/10.1016/j.neurobiolaging.2010.03.004>

Wilson, R. S., Bienias, J. L., Berry-Kravis, E., Evans, D. A., Bennett, D. A., 2002. The apolipoprotein E ϵ 2 allele and decline in episodic memory. *J Neurol Neurosurg Ps* 73(6), 672-677. <https://doi.org/10.1136/jnnp.73.6.672>

Wisdom, N. M., Callahan, J. L., & Hawkins, K. A., 2011. The effects of apolipoprotein E on non-impaired cognitive functioning: a meta-analysis. *Neurobiol Aging* 32(1), 63-74. <https://doi.org/10.1016/j.neurobiolaging.2009.02.003>

Woodcock, R.W., Johnson, M.B., Mather, N., 1989. Woodcock-Johnson Psychoeducational-Revised. DLM Teaching Resources, Allen, Texas.

Xu, Q., Liang, Z., Huang, Y., 2024. APOE4 homozygosity is a new genetic form of Alzheimer's disease. *Nat Med* 30, 1241–1242 (2024). <https://doi.org/10.1038/s41591-024-02923-w>

Chapter Three: Bridging Chapter

As a main conclusion of my systematic review, I argued that a more precise and ecologically valid assessment of episodic and semantic memory in people at increased genetic risk of developing AD could derive from interview protocols that are designed to probe the recall of autobiographical events. In this regard, a detailed assessment of autobiographical memory in this population could clarify if the impact of *APOE* ϵ 4 is limited to episodic memory only, as suggested by previous research findings (Small et al., 2004; Wisdom et al., 2011; O'Donoghue et al., 2018; see also Grilli et al., 2018), or whether it also extends to semantic memory, in particular personal and general semantic forms of declarative memory (see Grilli et al., 2021).

These forms of declarative memory have been recently investigated in the field of memory research (Renoult et al., 2012, 2020; see also Strikwerda-Brown et al., 2019), even in more specific sub-categories (Melega et al., 2024; Renoult et al., 2012, 2016; Tanguay et al., 2018), but, so far, they have never been assessed in healthy older adults with increased genetic risk of developing AD, therefore representing an important gap in current research.

In the following empirical chapter of this thesis, I aimed to address this research gap by administering the Autobiographical Interview (AI; Levine et al., 2002) along with a novel version of the AI, the Semantic Autobiographical Interview (SAI; Melega et al., 2024) in a group of healthy older *APOE* ϵ 4 carriers and a group of non-carriers with similar age and education.

Chapter Four: Empirical Study

Prepared for Submission to *Psychology & Aging* (American Psychological Association) after being invited to submit by the guest editors of a special issue on “Age-related changes in memory for gist and details: New perspectives on the representational quality of episodic memory” (<https://www.apa.org/pubs/journals/pag/age-related-changes-representational-quality-episodic-memory>)

Author guidelines and details of the special issue can be found in Appendix D.

Proof of ethics approval can be found in Appendix E.

Screening measures can be found in Appendix F.

Interview protocol instructions are in Appendix G.

Participant Information Sheet, Consent Form and Debrief Form are respectively in Appendix H, I and L.

Assessing Episodic and Semantic Autobiographical Recall in Healthy Older *APOE* ε4 Carriers

Short title: Episodic and Semantic Recall in *APOE* ε4 carriers

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Abstract

The *APOE* $\epsilon 4$ gene is associated with increased risk of developing sporadic Alzheimer's Disease (AD). Several studies have focused on declarative memory, where episodic memory deficits are reported in $\epsilon 4$ carriers, while semantic memory has received much less attention. To clarify whether the impact of *APOE* $\epsilon 4$ on declarative memory is specific to episodic memory, we administered a novel measure of autobiographical memory, the Semantic Autobiographical Interview (SAI). Thirty-eight healthy older adults were recruited, 19 $\epsilon 4$ carriers and 19 non-carriers, similar in age, education, and gender. The groups did not significantly differ in any neuropsychological tests except for recognition memory, where $\epsilon 4$ carriers showed reduced performance. Autobiographical memory results revealed a reduced number of internal and external episodic details in carriers on the original AI, but no difference in personal and general semantic production in any other section of the interview. These results indicate that episodic memory specificity appears to be selectively reduced in healthy older $\epsilon 4$ carriers, for both on-task (internal details) and off-task (external events) episodic details, and in a test of recognition memory. Instead, $\epsilon 4$ carriers had very similar semantic production to non-carriers, whether it was for off-task semantic details in the AI (external semantic), or on-task general and personal semantic details produced in the general semantic and personal semantic parts of the interview. Our results suggest that older adults retain the gist of their personal experience and the semanticization of their autobiographical narratives is robust and less sensitive to AD genetic risk than episodic memory.

Public Significance Statement

People at risk for Alzheimer's Disease struggle with recalling memories from specific events (episodic memory), but it remains unclear whether they also have difficulties with personal and general semantic memory. We used the Semantic Autobiographical Interview, which targets personal and general semantic memories, in people at risk for Alzheimer's Disease. Our findings indicate that these participants showed reduced episodic memory, while personal and general semantic memory was not impaired.

Introduction

Narrative analysis is a naturalistic and ecologically valid measure of autobiographical memory recall that is sensitive to subtle memory impairments (Irish, 2023; Simpson et al., 2023), especially when cognitive deficits evade standardized neuropsychological assessment (see Levine et al., 1998). To evaluate autobiographical recall specifically in healthy cognitive aging, Levine and colleagues (2002) designed an interview protocol that distinguished between episodic and semantic memory details during event narration, the Autobiographical Interview (AI). In the AI, participants are instructed to retrieve specific personal memories (i.e., from a specific time and place) from different life periods through a graded retrieval procedure starting from free recall and followed by general and specific probes. Levine et al. (2002) reported that older adults recalled fewer episodic (or internal) details related to the events than younger adults, but also showed a higher recall of external details (i.e., semantic details, unsolicited repetitions, comments, metacognitive statements, and details about events not related to the main episode selected by the participant) across the life periods selected. The authors, therefore, concluded that episodic memory is somehow affected in healthy aging, while semantic memory seems to be better preserved, or even facilitated (see also St Jacques & Levine, 2007). Several explanations have been advanced to account for the increase in external details in aging: older adults could show difficulties with suppressing non-pertinent information during recall, likely due to impaired executive control (Amer et al., 2016, 2018, 2019, 2022; Levine, 2004; Spreng et al., 2018), while others argued that this enriched production of external details may act as compensation for reduced production of internal details (Devitt et al., 2017; Sheldon et al., 2024; for a review, see Grilli & Sheldon, 2022).

Ever since this initial study, the AI has been employed in hundreds of studies involving clinical and healthy cohorts. In a recent meta-analysis, Simpson et al. (2023) noted that the

finding of reduced internal details and increased external details in healthy aging is evident and robust across all the reviewed studies (Acevedo-Molina et al., 2020; Addis et al., 2008, 2009; Aizupurua & Koutstaal, 2015; Barnier et al., 2014; Cao et al., 2018; De Brigard et al., 2017; Devitt et al., 2016; Diamond et al., 2020; Ford et al., 2014; Gaesser et al., 2011; Levine et al., 2002; Madore et al., 2014; Peters et al., 2019; Robin & Moscovitch, 2017; Spreng et al., 2018; St Jacques & Levine, 2007; Wank et al., 2021; Zavagnin et al., 2016). Moreover, compared to healthy aging, the retrieval of episodic internal details on the AI is increasingly more affected in Mild Cognitive Impairment (MCI – Barnabe et al., 2012; Bastin et al., 2013; Coelho et al., 2019; Gamboz et al., 2010; Murphy et al., 2008) and, to a greater extent, in Alzheimer’s Disease (AD – Addis et al., 2009; Barnabe et al., 2012; Benjamin et al., 2015; Irish et al., 2011, 2012, 2018; Meulenbroek et al., 2010), while the effect of increased recall of external details gradually fades with the presence of MCI and AD (see Muelenbroek et al., 2010).

Similar results have been observed using other tests of autobiographical memory in healthy aging, such as the Autobiographical Memory Test (AMT), where older adults typically retrieve a smaller amount of specific memories (e.g., Ros et al., 2009; 2018; Barry et al., 2020), the TEMPau (Piolino et al., 2003, 2006) where a reduction in sensory-perceptive, affective or spatiotemporal details has been observed, or the Episodic Autobiographical Memory Interview (EAMI; Irish et al., 2011), where older adults exhibited a recency effect with progressively increased recall of contextual details for more recent life periods.

Overall, the research evidence in the field of autobiographical memory has so far provided extensive insights into episodic memory recall in aging, yet the role of semantic memory remains to be clarified, especially when considering personal and general forms of semantic memory. While personal semantics are idiosyncratically personal (e.g., someone’s favourite movie or knowledge about one’s preferences), general semantics are culturally shared and pertain to public and accessible information (e.g., the name of a Prime Minister during a

specific historical period). A common finding in aging indeed consists of decreased recall of episodic events and relatively spared or less pronounced deficits in personal semantics (Acevedo-Molina et al., 2020; Melega et al., 2024; Renoult et al., 2020). However, on the original AI (and in most tests of autobiographical memory), semantic memory recall is incidental, since participants are instructed to recall episodic memories. Semantic details are part of external details and classified as off-topic utterances, and thus these external details do not represent a true assessment of semantic memory, as illustrated by the fact that they are sparsest in healthy younger participants, who presumably have no semantic processing impairment (Renoult et al., 2020; Simpson et al., 2023). Moreover, while external details are well-known to be elevated in healthy aging and neurodegenerative diseases (see Grilli & Sheldon, 2022), such details in the AI not only include general and personal semantic details, but also metacognitive statements, comments, repetitions, and details about off-topic events, and are thus not a pure measure of semantic processing.

Personal and General Semantics: the Semantic Autobiographical Interview

Renoult et al. (2020) introduced a new scoring procedure for the AI to differentiate subtypes of external details to test whether the elevation of these details in aging and in frontotemporal lobar degeneration (including mixed frontotemporal/semantic dementia (FTD/SD) and progressive non-fluent aphasia (PNFA) would be specific to general and personal semantics or would concern all subtypes. While the increase in external details concerned all types of semantic details (both personal and general) in healthy older adults (see also Acevedo-Molina et al., 2020), participants with FTD and SD showed an excess of personal semantic but not general semantic details. These results can be related to the observations that patients with FTD – in particular SD – have an impairment in recalling general semantic

knowledge (Lambon Ralph et al., 2017), but better preservation of personally relevant concepts (Duval et al., 2012; McKinnon et al., 2008).

Melega and colleagues (2024) recently developed a new version of the AI, the Semantic Autobiographical Interview (SAI), that directly targets personal and general semantics alongside episodic memory in different sections of the interview, allowing a less ambiguous interpretation of semantic recall in aging. The SAI was tested alongside the original AI among healthy older and younger adults, and it was found that older adults reported lower proportions of target details and more external details not probed by the instructions across the three interviews (i.e., off-task utterances or ‘stories aside’; see Bluck et al., 2016). As compared to young adults, older adults also consistently produced more autobiographical facts and self-knowledge across interviews, which could reflect a bias towards personal semantic information in healthy aging regardless of task instructions. Although the study also observed the typical reduction of internal details in older adults in the AI, their other findings suggest that the shift in narrative style among older adults goes beyond episodic remembering (Bluck et al., 2016; Hasher & Zacks, 1998; James et al., 1998; Trunk & Abrams, 2009).

Autobiographical Memory and *APOE* ϵ 4

Given the potential of autobiographical memory retrieval as a sensitive and subtle measure of cognitive decline in people at the preclinical stage of AD, recent research has started to expand its investigation with healthy people at increased genetic risk of developing the disease. The ϵ 4 variant of the Apolipoprotein (*APOE*) gene is associated with an increased risk of developing sporadic late-onset Alzheimer’s Disease (AD) (Corder et al., 1993; Borgaonkar et al., 1993), with an earlier age of onset (Blacker et al., 1997). Since *APOE* ϵ 4 is the strongest genetic risk factor for late-onset AD (Fortea et al., 2024), several studies have focused their

attention on how it could influence cognitive decline in non-demented healthy older adults. One such area is declarative memory, where episodic memory deficits have been reported in $\epsilon 4$ carriers (Small et al., 2004; Wisdom et al., 2011; O'Donoghue et al., 2018), consistently with its early impairment in AD (McKhann et al., 2011). In contrast, the impact of *APOE* $\epsilon 4$ on semantic memory has received much less attention, though it has also sometimes been reported to be impaired in mild cognitive impairment and early AD (Chasles et al., 2020; Joubert et al., 2010, 2020; Storandt, 2008; Taler et al., 2016, 2020).

A study using the AI in $\epsilon 4$ carriers reported a reduced number of episodic details during autobiographical recall, but no difference in external details relative to non-carriers (Grilli et al., 2018). This could indicate a selective impairment of episodic memory in $\epsilon 4$ carriers. Similar findings in *APOE* $\epsilon 4$ carriers were also observed by Acevedo-Molina et al. (2023) when assessing past and future autobiographical thinking. However, as stated above, external details in the AI not only include general and personal semantic details, but also metacognitive statements, comments and repetitions, and details about off-topic events, and are thus not a pure measure of semantic processing.

In a related study (Grilli et al., 2021), healthy middle-aged and older *APOE* $\epsilon 4$ carriers and non-carriers were also administered an autobiographical memory fluency task, where participants were required to generate instances of episodic memories and personal semantics (see Ditschel et al., 1992; Addis & Tippett, 2004). Carriers reportedly showed a fluency deficit in the generation of episodic and personal semantic exemplars, suggesting some underlying autobiographical memory alterations in people at increased genetic risk of developing AD. Even more recently, Knoff et al. (2024) compared direct (i.e., rapid) and iterative (i.e., generative) retrieval processes in *APOE* $\epsilon 4$ carriers and non-carriers. Direct retrieval was found to be reduced in carriers, meaning that people with increased genetic risk for AD could also

show increased difficulty in the rapid reconstruction of specific autobiographical memories without the aid of semantic memory.

However, like most tests of autobiographical memory, the AI instructs participants to retrieve episodic memories, and thus the interpretation of external details remains ambiguous. What is, therefore, still missing in current research is a direct comparison between episodic memory and personal and general forms of semantic memory when assessing autobiographical recall.

The present study

To address this issue and clarify whether the impact of *APOE* $\epsilon 4$ on declarative memory is specific to episodic memory, in the present study we administered a new measure of autobiographical memory, the SAI (Melega et al., 2024), to cognitively unimpaired older *APOE* $\epsilon 4$ carriers and non-carriers, along with the original AI. The SAI explicitly targets personal and general semantic memories with the aim of better understanding the production of semantic information during autobiographical recall. External details were segmented into subtypes of semantic and other details (see Renoult et al., 2020). From a clinical perspective, such comparison could cast light on the function of personal and general semantic details among healthy older people with increased genetic risk for AD and verify whether cognitive decline in this population is specific or not to episodic memory.

In line with previous research (Grilli et al., 2018), we hypothesised that people with *APOE* $\epsilon 4$ would show decreased episodic recollection of event-specific experiences (i.e., episodic internal details). As to personal and general semantic memory details, it instead remains unclear whether the *APOE* $\epsilon 4$ group would show an increased or a decreased recall of these details, given that previous research in the field did not directly probe for semantic details

as indicated by the standard AI instructions (Grilli et al., 2018) or used different research paradigms (see Grilli et al., 2021). The existing literature suggests the impact of *APOE* $\epsilon 4$ on semantic memory may be limited (Wilson et al., 2002; Buckley et al., 2014; for a review see Sacripante et al., 2025), though there are only a few relevant studies, and they mostly used simple neuropsychological tests like naming (Duchek et al., 2006; Eich et al., 2019) that are not a good match for episodic tests, as well as tests like category fluency that also rely on executive functions (Helkala et al., 1995; Ford et al., 2020; Nilsson et al., 2006; Rosen et al., 2005; Salo et al., 2001; Tse et al., 2010; Wikgren et al., 2013).

As to whether carriers would recall more, or fewer personal and general semantic details compared to non-carriers, it could be speculated that forms of personal semantics such as memories of repeated events, that have similar neural correlates as episodic memory (Renoult et al., 2012), are likely to be more affected in *APOE* $\epsilon 4$ carriers than other forms such as autobiographical facts, that are more similar to general semantics (Grilli et al., 2021), but the evidence so far remains limited.

Methods

Participants

A total of 38 healthy older adults with an average age of 67.76 years (15 women, range: 61-83 years, $SD = 6.05$) and an average of 15.31 years of education (range: 6-26 years, $SD = 3.41$) were recruited at the Department of Psychology of the University of East Anglia. To be eligible for the study, all the participants needed to be over the age of 60, either English native speakers or having learned English early in life, to have normal or corrected to normal vision (i.e., wearing glasses or contacts, as required), and have no diagnosed psychiatric or neurological conditions. We conducted an a priori power analysis using G*Power (Faul et al., 2009), which indicated a minimum total number of 36 participants, assuming a power of 0.90, a medium effect size ($\eta^2_p = 0.06$, equal to a Cohen's d effect size of 0.25) and an error probability of .05.

To rule out any potential cognitive decline, participants completed the Addenbrookes Cognitive Examination (ACE-III; Mioshi et al., 2006; Hsieh et al., 2013) as a screening tool, and an extended neuropsychological assessment for global cognition through the online platform NeurOn (<https://neuropsychology.online/>). The battery included the Digit Span Backwards (Wechsler, 1987), the Trail Making Test Part A and Part B (Reitan, 1958), and tests of word recognition and source memory (for more details on these tasks, see Melega et al., 2024).

All the participants were also asked to complete screening for anxiety (Generalised Anxiety Disorder, GAD-7; Spitzer et al., 2006), depression (Patient Health Questionnaire, PHQ-9; Kroenke et al., 2001), and quality of sleep (Pittsburgh Sleep Quality Index, PSQI; Buysse et al., 1989). These questionnaires were accessed and completed through Qualtrics

(Qualtrics International, Inc., Provo). These measures were administered to control any potential group differences that could have influenced or accounted for different patterns of memory recall.

This research project was part of a Medical Research Council grant (MRC-MR/S011463/1) and was granted ethical approval from the Research Ethics Committee of the School of Psychology of UEA (project: 2019-0714-001555, initially approved in May 2020; amendments approved in June 2023: ETH2223-2509). Ethical approval for this research project was also granted by the National Research Ethics Service (NRES) for the dementia Research and Care Clinical protocol (approved REC reference:16/LO/1366). All the participants provided their informed consent before taking part in the study and they were free to withdraw at any time. Participants received an honorarium for their research participation.

Table 1. Demographics and mean scores on the questionnaires and neuropsychological tests for $\epsilon 4$ Carriers and non-carriers.

	$\epsilon 4$ Carriers N, Mean (SD)	Non-carriers N, Mean (SD)	Significance
Age (years)	19, 68.42 (6.35)	19, 67.10 (5.83)	$p = .255$
Education (years)	19, 15.00 (2.58)	19, 15.63 (4.13)	$p = .288$
Gender (F:M)	12:7	13:6	$\chi^2 = .732$
ACE-III	19, 95.84 (3.37)	19, 95.47 (2.71)	$p = .356$
PHQ-9	11, 1.81 (1.53)	15, 2.66 (2.25)	$p = .293$
GAD-7	11, 1.27 (1.79)	15, 2.40 (2.92)	$p = .568$
PSQI	11, 4.90 (3.27)	15, 4.46 (2.70)	$p = .709$
Digit Span Backwards	17, 5.17 (1.97)	19, 5.31 (1.94)	$p = .416$
Trail Making B-A time	19, 21.36 (19.06)	18, 19.27 (30.75)	$p = .402$
<i>Episodic memory tests</i>			
Word Recognition accuracy (d')	18, 81.55% (14.27)	18, 90.00% (9.10)	$p = .020^*$
Source Memory accuracy (hits)	18, 46.27% (17.80)	18, 53.66% (17.66)	$p = .109$

*statistically significant at $p = 0.05$

DNA extraction and *APOE* Genotyping

DNA was collected via sterile brush or cotton buccal swabs by qualified research assistants. To ensure participants had not had any food or drink 30 minutes prior to the swab, this step was always completed after the task. All swabs were air-dried at least two hours before processing and all swabs were processed within one week. More information on DNA extraction and *APOE* genotyping can be found in Chapter 5.

Experimental Procedure

Participants were contacted by the research team through advertisements to the university's volunteer panel. The experimental procedure included multiple online sessions via Microsoft Teams. Ahead of testing, participants were asked to provide demographic information and complete psychological questionnaires (GAD-7, PHQ-9 and PSQI) through an online questionnaire (on Qualtrics).

The first online session took approximately one hour, and it involved the completion of cognitive screening. After completing these tests, in preparation for the autobiographical interview, participants were asked to list personal chapters from their life by segmenting their last 30 years as chapters (e.g., a life chapter every five years starting from the present year). Every participant listed as many chapters as they wished, whereby each chapter ranged from one to five years long. Every listed chapter was assigned a title with beginning and ending dates.

The second session took place online via Teams between two and seven days after the initial one, and it took a minimum of one hour to be completed, with breaks provided to avoid participants' fatigue. Participants were asked to consider the life chapters from last year and the one from 10 years ago, which were used as personalised temporal cues for memories throughout the different sections of the interview. If participants selected multiple chapters from the same years (e.g., 10 years ago), they were then asked to choose the chapter they felt most confident with. Participants completed the original AI, the personal semantic version of the SAI (i.e., PSAI) and the general semantic version of the SAI (i.e., GSAI). Crucially, both

life chapters were recalled in AI and PSAI, while the GSAI only concerned the most recent one (i.e., last year), as in Melega et al. (2024)².

As the transcripts represented the main source of data for this study, the whole online session was recorded and transcribed simultaneously. On the AI, participants were asked to describe in detail a specific event from two life chapters selected (i.e., last year and 10 years before) and could recall any type of event as long as they felt comfortable with it. Specific probes regarded spatiotemporal, perceptual, and emotional aspects concerning the selected event in line with the administration manual of the AI (see Levine et al., 2002). While undertaking the PSAI, participants were instructed to describe what was going on in their life during the selected life chapter (instruction: *“if you wanted to tell me how that life chapter was like for you, how would you describe it?”*, see Melega et al., 2024). On the PSAI, specific probes concerned autobiographical facts (regarding personally relevant facts, people and places), repeated events (e.g., weekly habits, routines, hobbies), and self-knowledge information (e.g., personality traits and character, opinions, and beliefs, preferences) from the same two life chapters as in the AI (i.e., last year and 10 years before). The administration of the original AI and the PSAI was counterbalanced for each participant.

After the AI and the PSAI, all participants completed the GSAI, where they were asked to recall general semantic information, defined as culturally shared general knowledge (Tulving, 2002). Thus, participants had to describe what was going on in their local community, country, or around the world (instructions: *“if you wanted to tell me what was happening in your community, in the UK or around the world during that specific life chapter, what would*

² In Melega et al. (2024) general semantic testing was restricted to last year only in the context of a comparison between younger and older adults. Pilot data showed that younger participants had significant difficulties in recalling public events and culturally shared knowledge from 10 years before the interview (e.g., childhood times).

you say?”). On the GSAI, specific probes concerned public events, public figures, and trends and popular things (e.g., films, music, fashion)

At the end of this session, participants were informed that testing was over and were debriefed about the study. Debriefing also included information about payment for their research participation.

Detail scoring procedure

As stated above, all participants consented with the interviews being recorded and automatically transcribed using Microsoft Teams and then manually edited by three researchers (RS, TJ). In line with Melega et al. (2024), memories were scored following the method described by Levine et al. (2002) and the recent taxonomy of semantic details proposed by Renoult et al. (2020). Interview transcripts were segmented into memory details which were classified as episodic, autobiographical facts, self-knowledge, repeated events, general semantic, repetitions and other. *Table 2* provides a definition and practical examples of each type of memory detail.

Table 2. Definition of Detail types and relative examples

Detail Type	Definition	Examples
Internal details	Unfolding of the event, spatiotemporal, perceptual and emotional details.	Last year I visited Mexico; I was quite fascinated; There was a crocodile on the right side of the riverbank.
External events	Specific details from other incidents external to the main event recalled.	On the same year I also visited Morocco.
Autobiographical fact	Basic (objective) information about personal life circumstances, factual element of unique episodes.	I lived in Scotland for a few years; I have a younger sister.
Self-knowledge	Personality traits and character, opinions and beliefs.	I was very happy during that time; I quite like watching football.
Repeated Event	Common elements of repeated episodes.	I go to the gym three times a week; I walk to the office every day.
General Semantic	Culturally shared knowledge (e.g.,neighbor community, country, world).	Rome is the capital of Italy; the UK general elections took place this year
Repetition	Information that has already been recalled.	As I mentioned, the UK general elections happened this year.
Other	Metacognitive statements and editorializing.	Right, let me have a think; I don't know; I can't think of anything that happened during that time.

Interview transcripts were rated by two independent scorers (RS and TJ) who were trained on the original AI scoring method (Levine et al., 2002), as well as on the novel scoring method for external details (Renoult et al., 2020). To estimate interrater reliability, six memories from the original AI (15.8%), six from the PSAI (15.8%), and six from the GSAI (15.8%) were randomly selected and scored by both scorers, who were blind to the group allocation of each participant. As in Melega et al. (2024), we calculated interrater reliability separately for each interview by referring to Intraclass Correlation Coefficient (ICC; two-way, random effects model). After collapsing the specific categories into macro-categories (Internal vs External), inter-rater reliability on internal details was excellent across interviews (ICCs for the AI > 0.96, ICCs for the PSAI > 0.92, ICCs for the GSAI > 0.97), as well as for external details (ICCs for the AI > 0.92, ICCs for the PSAI > 0.85, ICCs for the GSAI > 0.97).

The interview transcripts from the remaining participants were allocated to the scorers in pseudorandom order, by making sure they were blinded to the group allocation of each participant scored (i.e., $\epsilon 4$ carriers or non-carriers), which could have biased their scoring. We used a script developed in MATLAB (Mathworks, Inc.) for the automated counting of the memory details on the interview transcript of each participant, to ease scoring and to minimise human error (see Wardell et al., 2021; Melega et al., 2024).

Design and Analysis Plan

Ahead of data analysis, we employed a winsorization process for all the scored memories to re-adjust positively skewed data (see Renoult et al., 2020, Melega et al., 2024). With this procedure, we rescaled detail counts that were ± 2.5 SD from the mean so they were 2.5 SD from the mean (see McKinnon et al., 2008, 2015), for a total of 43 winsorized data points, which accounted for 3.05% of the total scores (for carriers, 1.31%, 2.85%, 1.42% of

AI, PSAI, GSAI, respectively; for non-carriers, 5.60%, 3.21%, 2.14% of AI, PSAI, GSAI scores, respectively). As in Melega et al. (2024), we averaged detail counts across recent and remote memories, since the effect of time-period was not significant.

In this study, we report the analyses on averaged cumulative scores, which include free recall, general probe, and specific probe. This approach allowed us to refer to more robust estimates of group differences due to increased observations and smaller error variance (see Melega et al., 2024). Detail counts of cumulative recall represented our main measure of interest. Although we did not expect differences in narrative length due to verbosity between our two groups of older adults, proportional details (i.e., details count divided by the total number of details produced by each participant) were also considered as a measure of interest for cumulative recall.

As in Melega et al. (2024), target detail scores corresponded to episodic details for the AI, personal semantic details (autobiographical facts, self-knowledge, and repeated events) for the PSAI, and general semantic details for the GSAI. Proportional scores of target details were calculated by dividing these detail categories by the total number of details. For the analysis of target details between interviews, we employed a 2x3 mixed design, with Group as a between-subjects variable (carriers vs non-carriers), Interview as within-subjects variable (AI, PSAI and GSAI) with the respective target detail score on each interview as an outcome variable. To verify the consistency of individual differences in recall after different instructional manipulations, we also calculated rank-order correlations of the count target details recalled across interviews with Kendall-Tau tests (see Chapter Six).

To consider the participants' differences in the elaboration of specific details within each interview, we also adopted a mixed design, with Group as between-subjects variable, and detail types (Episodic, Autobiographical Facts, Self-knowledge, Repeated Events, General

Semantic events, Repetition, Other) as within-subjects variable. For the original AI, the category of Episodic details was divided into internal details and external events as specified in the interview protocol (Levine et al., 2002) including a 2x8 mixed design, while for the PSAI and the GSAI this category only included External Events (i.e., 2x7 mixed design).

Analyses were carried out in R Studio (version 4.0.3). Following previous research (Melega et al., 2024), which used a similar design and procedure, statistical analyses involved mixed factorial analyses of variance (ANOVAs) to assess group differences (carriers vs non-carriers) for target details on each of the three interviews, and the different levels of detail elaboration within interview. If the assumption of normal distribution for parametric testing was violated, mixed ANOVAs were also computed using permutation tests as a non-parametric statistical, with a maximum number of 1000 iterations. Post-hoc tests involving detail type and groups were computed via pairwise comparisons of estimated marginal means with emmeans package in R (Lenth et al., 2014) corrected for false discovery rate (Benjamini & Hochberg, 1995). To compare carriers and non-carriers on the demographic and neuropsychological tests we used independent *t*-tests and chi-squared tests (see *Table 1*).

Results

Our sample consisted of 19 ϵ 4 carriers (ϵ 3 ϵ 4 $n = 16$, ϵ 4 ϵ 4 $n = 2$, and ϵ 2 ϵ 4 $n = 1$) and 19 non-carriers (ϵ 3 ϵ 3 $n = 16$, and ϵ 2 ϵ 3 $n = 3$). The two groups had similar age, years of education and gender (see *Table 1*). All participants completed the ACE-III and scored above threshold (Mioshi et al., 2006), and no difference between carriers and non-carriers was observed. A total of 35 participants completed the rest of the battery of neuropsychological tests. One carrier failed to complete the digit span backward only, another carrier did not complete both the digit span backward and the episodic memory tests, and one non-carrier participant did not complete

any of these tests, likely due to technological issues with accessing or completing these tests online. No significant group differences were noted between *APOE* $\epsilon 4$ carriers and non-carriers on any of the demographic measures, cognitive screening and neuropsychological tests, apart from the Word Recognition accuracy index (d') of the episodic memory test, where carriers performed significantly worse ($p = .020$). Correlations between performance in neuropsychological tests and outcome measures are reported in Chapter 5.

***APOE* group differences in the production of target details across interviews**

Figure 1 shows the total average counts of target details produced by carriers and non-carriers in each interview (see also *Table 3*). Target details were internal details in the AI, the sum of Autobiographical Facts, Self-Knowledge and Repeated Events details for the PSAI, and General Semantic details for the GSAI.

As illustrated by the main effect of Interview, $F(2,108) = 75.492$, $\eta^2_p = 0.58$, 95% CI [0.48, 1.00], $p < .001$, participants produced a significantly higher amount of target details on the PSAI ($M = 101$, $SD = 32.2$) as compared to the GSAI ($M = 32.0$, $SD = 16.2$), $t(108) = 12.101$, $p < .001$, and the original AI ($M = 77.30$, $SD = 25.90$), $t(108) = 4.202$, $p < .001$. The target detail production on the GSAI remained markedly lower than the other interviews, most likely because data from one life period only (i.e., last year) was used for the GSAI, while data from two life periods was used for both the AI and the PSAI.

There was a significant interaction between Interview and Group, $F(2,108) = 4.031$, $\eta^2_p = 0.07$, 95% CI [0.01, 1.00], $p = .011$, as non-carriers produced significantly more target details ($M = 87.31$, $SD = 20.28$) on the original AI than carriers ($M = 67.31$, $SD = 27.53$), $t(108) =$

2.463, $p = .015$, while both groups produced similar rates of target details on the PSAI, $t(108) = -1.541$, $p = .126$, as well as on the GSAI, $t(108) = 0.198$, $p = .843$.

When considering target details within each group, carriers produced more target details on the PSAI ($M = 107.69$, $SD = 36.85$) as compared to the AI ($M = 67.31$, $SD = 27.53$), $t(108) = 4.973$, $p < .001$, while this trend was not observed within the non-carriers group, who produced a similar rate of target details on both the AI ($M = 87.31$, $SD = 20.28$) and PSAI ($M = 95.18$, $SD = 26.33$), $t(108) = 0.969$, $p = .598$.³

³ A separate 2x2 ANOVA was also carried out by only including two levels in the within-subjects factor of Interview type (AI and PSAI). This revealed a significant main effect of Interview ($p < .001$) and a significant interaction between Interview and Group ($p = .014$). Post-hoc tests revealed that non-carriers produced significantly more target details on the AI than Carriers ($p = .033$). Within each group, non-carriers produced significantly more target details on the PSAI as compared to the AI ($p < .001$), while Non-carriers produced a similar rate of target details between the AI and the PSAI ($p = .395$).

Table 3. Sum of count scores in Carriers and Non- carriers for cumulative recall (Free Recall, General Probe, and Specific Probe) in the AI, PSAI, and GSAI

Detail type	AI		PSAI		GSAI	
	Carriers N, Mean (SD)	Non-carriers N, Mean (SD)	Carrier N, Mean (SD)	Non-carriers N, Mean (SD)	Carriers N, Mean (SD)	Non-carriers N, Mean (SD)
Internal details	19, 67.31 (27.53)	19, 87.31 (20.28)	-	-	-	-
External events	19, 45.45 (34.03)	19, 64.00 (32.82)	19,1.45 (1.43)	19,1.68 (2.24)	19,2.06 (3.38)	19,1.63 (2.40)
Autobio Facts	19, 6.38 (9.24)	19, 8.16 (5.16)	19,60.12 (22.75)	19,52.59 (15.69)	19,6.47 (6.06)	19,4.71 (6.18)
Self-Knowledge	19, 1.44 (2.47)	19, 2.44 (3.05)	19,28.31 (11.97)	19,26.23 (10.95)	19,20.21 (14.60)	19,17.15 (15.27)
Repeated Events	19, 0.02 (0.11)	19, 0.42 (0.58)	19,19.26 (7.86)	19,16.36 (6.38)	19,0.31 (0.82)	19,0.36 (0.66)
General Semantic	19, 2.44 (3.34)	19,4.83 (5.78)	19,5.38 (4.96)	19,3.88 (4.17)	19,31.15 (15.74)	19,32.76 (17.00)
Repetitions	19, 11.32 (9.33)	19,16.89 (9.63)	19,12.15 (8.65)	19,11.73 (6.65)	19,3.30 (3.17)	19,3.72 (2.45)
Other	19, 12.51 (8.38)	19,18.35 (9.24)	19,14.39 (7.33)	19,15.08 (8.45)	19,10.68 (7.23)	19,11.78 (8.96)

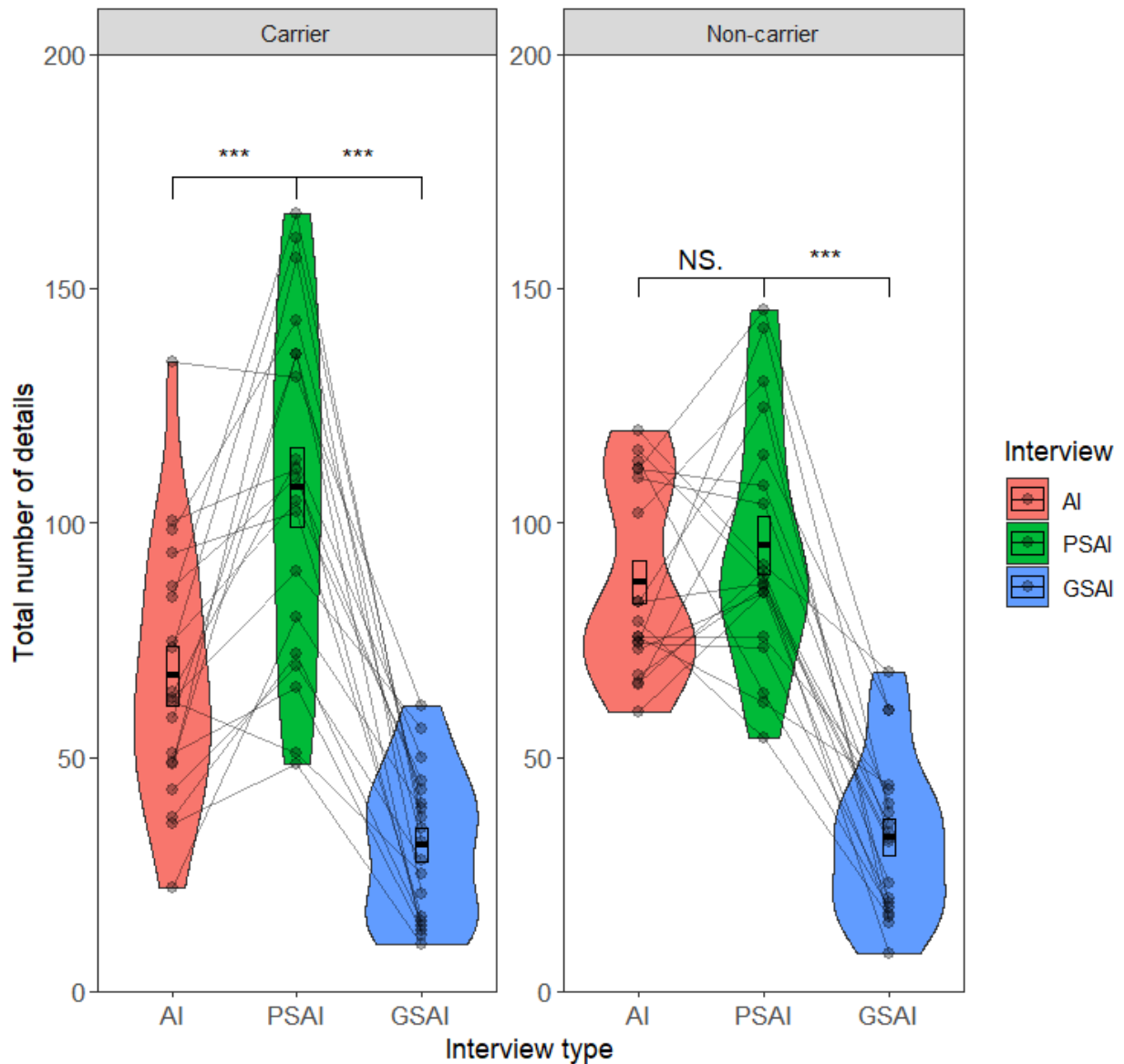


Figure 1. Counts of target details during cumulative recall in the Carrier and Non-carrier groups across interviews. Target details correspond to the information that was probed by task instructions: internal details in the AI; personal semantic details (autobiographical facts, self-knowledge, and repeated events) in the PSAI; general semantic details in the GSAI.

We also ran an analysis with proportional scores, which allowed for a direct comparison of target details produced on each interview despite the different number of life periods used (i.e., last year and 10 years ago in the AI and PSAI, last year only in the GSAI). *Figure 2* illustrates the cumulative proportional target details produced by carriers and non-carriers in

each interview (for descriptive statistics see Chapter Six). As in the main analysis with count scores, target details were internal details in the AI, the sum of Autobiographical Facts, Self-Knowledge, and Repeated Events details for the PSAI, and General Semantic in the GSAI.

As with count scores, there was a main effect of Interview, $F(2,108) = 92.634$, $\eta^2_p = 0.93$, 95% CI [0.54, 1.00], $p < .0001$, where participants in both groups produced the highest proportion of details on the PSAI ($M = 0.76$, $SD = 0.05$) as compared to the AI ($M = 0.46$, $SD = 0.10$) and GSAI ($M = 0.44$, $SD = 0.15$), where instead performance was similar. However, the main effect of Group was non-significant, $F(1,108) = 0.040$, $\eta^2_p = 0.003$, 95% CI [0.00, 1.00], $p = 0.842$, indicating that carriers and non-carriers overall generated similar rates of target details across interviews. The interaction between Group and Interview type was also non-significant, $F(2,108) = 0.996$, $\eta^2_p = 0.02$, 95% CI [0.00, 1.00], $p = 0.373$. These findings suggest that both groups were equally on task when producing target details in each interview.

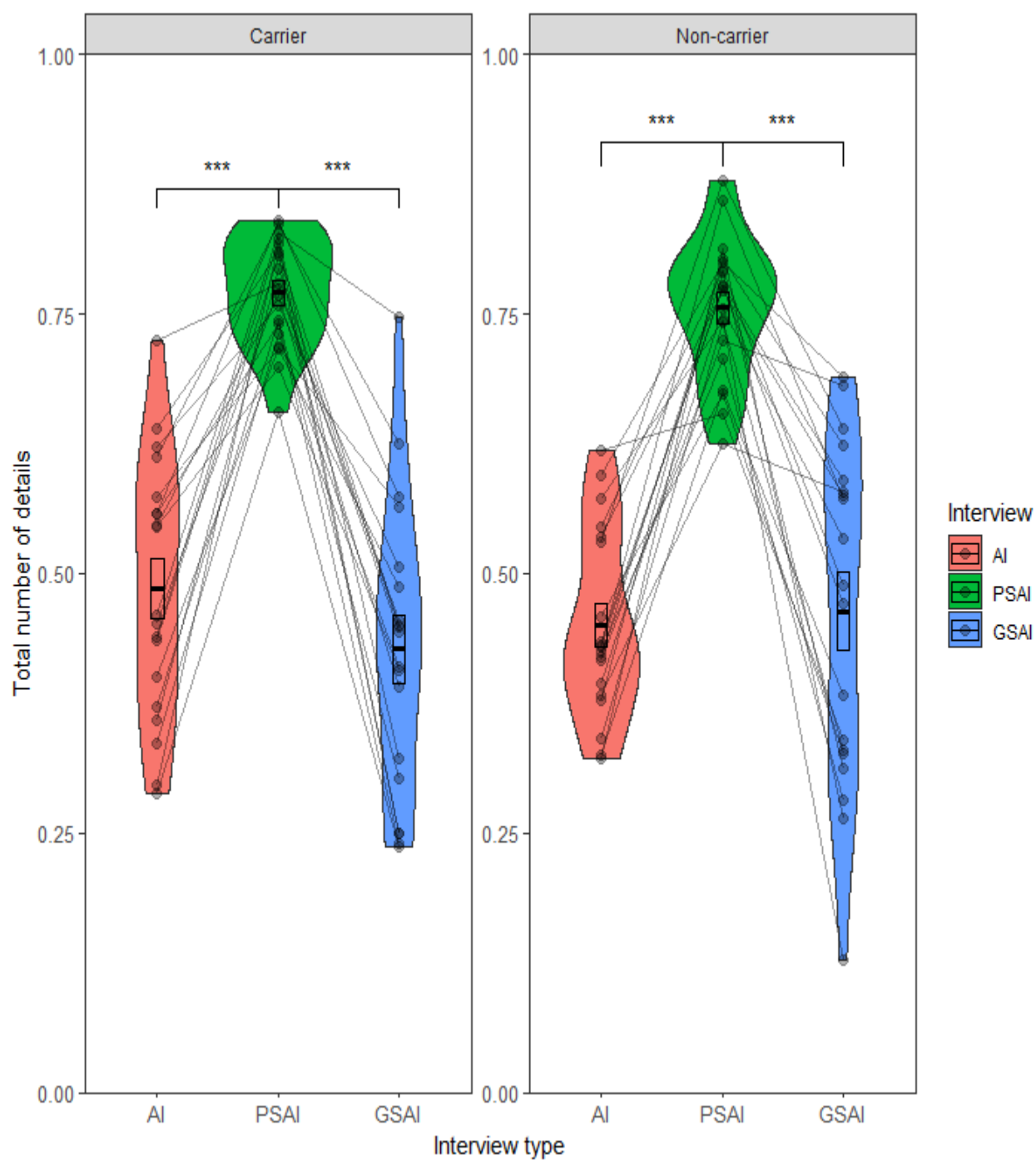


Figure 2. Proportions of target detail in cumulative recall in the Carrier and Non-carrier groups across interviews.

***APOE* group differences in detail elaboration in each interview**

To provide a fine-grain analysis around the production of target details across the three interviews, we also report data of detail elaboration for each interview (see *Figure 3* for AI, *Figure 4* for PSAI data, and *Figure 5* for GSAI data). Target details were internal details in the AI; Autobiographical Facts, Self-Knowledge, and Repeated Events in the PSAI; and General Semantics in the GSAI. Average count scores on each detail category can be found in *Table 3*. The same detailed analyses were carried out for proportional scores and can be found in Chapter Five.

Autobiographical Interview

When considering the average number of details produced on every category of details in the episodic narratives of carriers and non-carriers (see *Figure 3*), the ANOVA indicated a main effect of detail type, $F(7,288) = 125.61$, $\eta^2_p = 0.75$, 95% CI [0.72, 1.00], $p < .0001$, a significant main effect of group, $F(1, 288) = 15.21$, $\eta^2_p = 0.05$, 95% CI [0.02, 1.00], $p < .0001$, and a significant interaction between Detail type and Group, $F(7,288) = 2.382$, $\eta^2_p = 0.05$, 95% CI [0.00, 1.00], $p = .022$.

When comparing between groups, post-hoc pairwise comparisons revealed that carriers' episodic narratives included significantly lower rates of internal details ($M = 67.30$, $SD = 27.5$) than non-carriers ($M = 87.33$, $SD = 20.34$), $t(288) = -3.942$, $p < .001$, but also lower rates of external events ($M = 45.52$, $SD = 34.00$) as compared to non-carriers ($M = 64.00$, $SD = 32.81$), $t(288) = -3.655$, $p < .001$. This finding indicates that the specificity of episodic memory appears to be selectively reduced in carriers, and we further considered this in the *Discussion*. No significant between-group difference was observed for the other conditions

(Autobiographical Facts, $t(288) = 0.439, p = 0.66$; General Semantic, $t(288) = 0.470, p = 0.63$; Other, $t(288) = 1.151, p = 0.25$; Repeated Events, $t(288) = 0.27, p = 0.93$; Repetitions, $t(288) = 1.097, p = 0.27$; Self-Knowledge, $t(288) = 0.197, p = 0.84$).

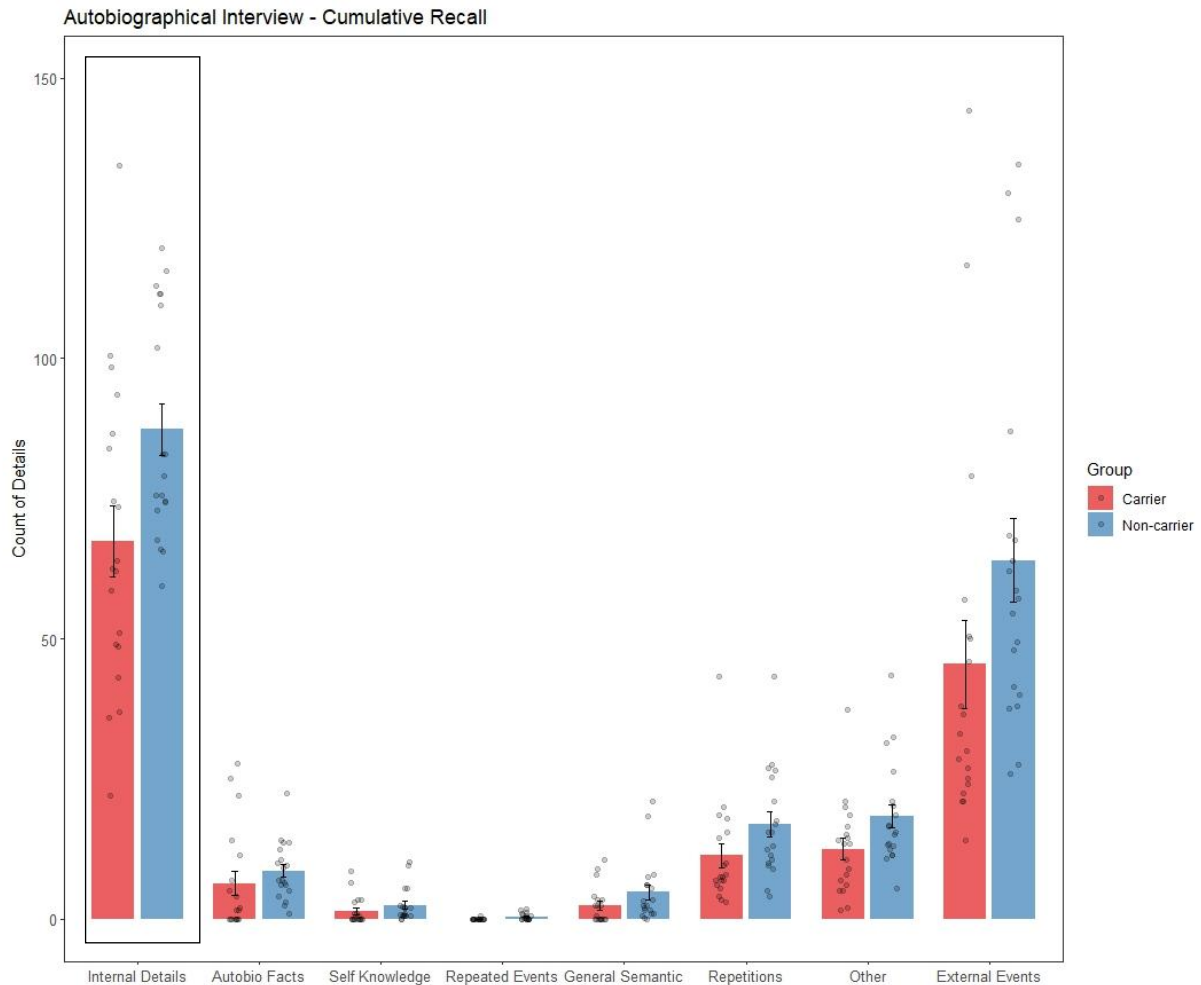


Figure 3. Counts of detail types during cumulative recall in the Carrier and Non-carrier group in the original AI, where target details were internal details (as highlighted by the black rectangle).

Personal Semantic Interview

When considering the count data of the different subtypes of details in carriers and non-carriers' narratives in the PSAI (see *Figure 4*), the ANOVA revealed a main effect of detail

type, $F(6,252) = 127.24$, $\eta^2_p = 0.75$, 95% CI [0.71, 1.00], $p < .001$, a non-significant main effect of Group, $F(1,252) = 2.440$, $\eta^2_p = 0.001$, 95% CI [0.00, 1.00], $p = .120$, and a non-significant interaction between Detail type and Group, $F(6,252) = 0.721$, $\eta^2_p = 0.02$, 95% CI [0.00, 1.00], $p = .633$.

This broadly indicates that, on the PSAI, carriers showed a very similar semantic production to non-carriers for on-task personal knowledge related to autobiographical facts⁴, repeated events, and self-knowledge, meaning that groups did not significantly differ in terms of how they described past life chapters.

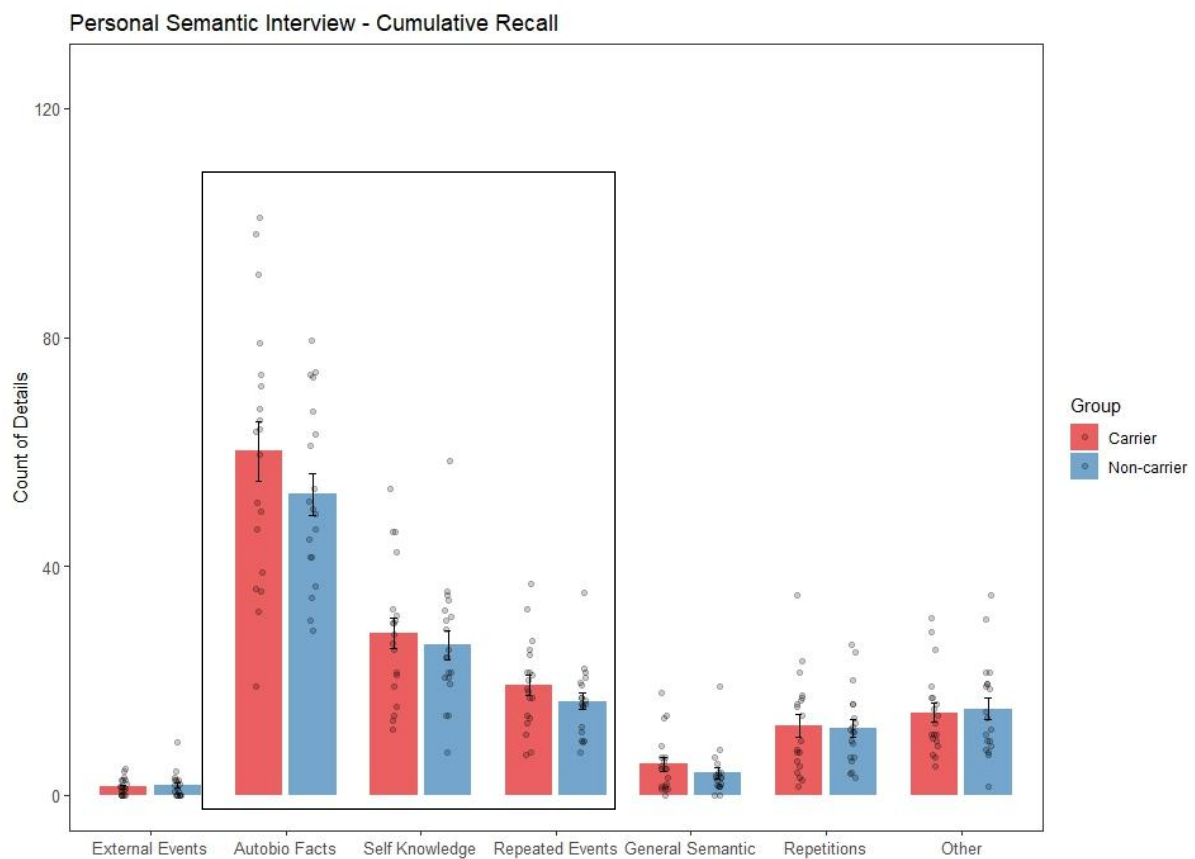


Figure 4. Counts of detail types during cumulative recall in the Carrier and Non-carrier group in the PSAI, where target details were Autobiographical Facts, Repeated Events, and Self-Knowledge (as highlighted by the black rectangle).

⁴ Post-hoc tests revealed that carriers' average scores in Autobiographical Facts were significantly higher than non-carriers ($p = .022$). It is however likely that this significant difference was masked after using a seven-level factor (Detail type).

General Semantic Interview

When considering the count data of the different subtypes of details in carriers and non-carriers' narratives of life chapters in the GSAI (see *Figure 5*), the ANOVA revealed a main effect of detail type, $F(6,252) = 56.31$, $\eta^2_p = 0.57$, 95% CI [0.51, 1.00], $p < .001$, a non-significant main effect of Group, $F(1,252) = 0.066$, $\eta^2_p = 0.002$, 95% CI [0.00, 1.00], $p = .797$, and a non-significant interaction between Detail type and Group, $F(6,252) = 0.289$, $\eta^2_p = 0.006$, 95% CI [0.00, 1.00], $p = .942$. As observed in the PSAI, these results indicate that carriers showed similar production of on-target general semantic details as non-carriers, as they did not significantly differ in how they described their general knowledge of the world.

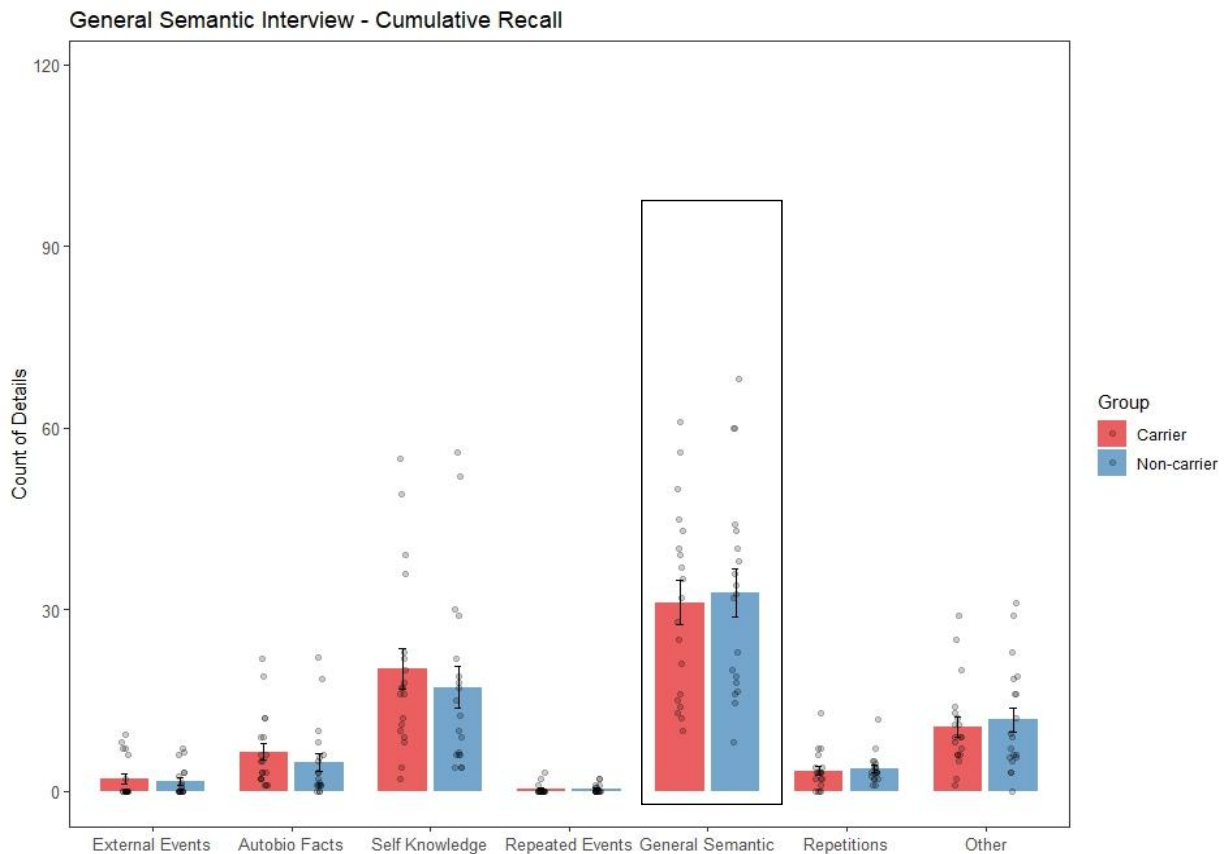


Figure 5. Counts of detail types during cumulative recall in the Carrier and Non-carrier group in the GSAI, where target details were General Semantic (as highlighted by the black rectangle).

Discussion

The analysis of narrative recall is an ecologically valid method to probe and measure naturalistic forms of declarative memory, especially when detecting subtle memory impairments, which could evade standard neuropsychological assessment. When looking at declarative forms of memory, people at increased genetic risk of developing late-onset AD commonly show deficits in episodic memory recall (Small et al., 2004; Wisdom et al., 2011), while their semantic memory abilities have substantially received less attention by current research. To verify whether the impact of *APOE* $\epsilon 4$ on declarative memory is specific to episodic memory, we here administered the novel SAI (Melega et al., 2024), which uses instructions manipulation to elicit personal and general semantic autobiographical content.

Overall, both $\epsilon 4$ carriers and non-carriers followed the interview instructions and modulated the content of their narratives so that internal episodic details were the highest on the original AI, while personal and general semantic details were the highest on the PSAI and GSAI respectively. When considering counts of target details across interviews, both carriers and non-carriers produced more target details on the PSAI, especially autobiographical facts and self-knowledge, as compared to the AI and GSAI. As argued by Melega et al. (2024), this finding could reflect a shift in the narrative style among healthy older adults (see also Devitt et al., 2017).

We also observed that non-carriers produced more elaborated narratives relating to personal past events, evidenced by a significantly higher amount of target details on the AI than carriers. Carriers also produced lower rates of both internal and external episodic events on the AI compared to non-carriers. These results are consistent with Grilli et al. (2018), whereby carriers were found to produce lower rates of internal details across life chapters on the original AI. Even though these authors also reported that carriers and non-carriers globally

generated similar rates of external details, they did not report participants' performance on subtypes of externals. After distinguishing between internal and external episodic events on the AI, we observed that episodic specificity appears to be selectively reduced in carriers, for both on-task (internal details) and off-task (external events) episodic details on the AI. This selective reduction of episodic memory ability was also observed in an episodic memory test of word recognition accuracy, where carriers showed reduced performance, in line with previous research that extensively reported episodic memory deficits in this population (Small et al., 2004; Wisdom et al., 2011; O'Donoghue et al., 2018).

Taken together, these results suggest a robust reduction in episodic specificity linked to genetic risk for AD observed with multiple measures (Bastin et al., 2013; Gamboz et al., 2010; Irish et al., 2011, 2012; Murphy et al., 2008; Tramoní et al., 2012). Among healthy older adults with genetic risk for AD, autobiographical narratives therefore appeared substantially less detailed relative to non-carriers. This could, arguably, represent a nuanced type of cognitive decline among carriers, reflecting subtle differences in narrative abilities whereby episodic specificity could be sensitive to $\epsilon 4$ status in cognitively unimpaired middle-aged and older adults (see Grilli et al., 2018).

In contrast, $\epsilon 4$ carriers and non-carriers showed similar semantic production, whether it was for off-task semantic details in the AI (external semantic), or on-task general and personal semantic details produced in the GSAI and PSAI (autobiographical fact, memories of repeated events, and self-knowledge). Thus, semantic types of autobiographical memory retrieval and general semantics could be relatively spared and preserved in people at increased genetic risk for AD, and carriers do not necessarily compensate for the subtle episodic memory impairment by producing additional personal or general semantic memory content. Previous research looking at semantic memory and $\epsilon 4$ status via standard neuropsychological tasks indeed failed to report consistent impairment in performance (Helkala et al., 1995; Laukka et

al., 2013; Nilsson et al., 2006; Seidenberg et al., 2009; Wikgren et al., 2012), therefore concluding that the impact of *APOE* $\epsilon 4$ on semantic memory could be limited (Wilson et al., 2002; Buckley et al., 2014, for a review see Sacripante et al., 2025). Studies looking at changes in brain anatomy or connectivity indeed showed a link between *APOE* $\epsilon 4$ and changes in medial temporal lobe regions, including the hippocampus, that are known to be essential for episodic memory (Donix et al., 2010; Gallagher & Koh, 2011; Machulda et al., 2011; Mishra et al., 2018; for reviews see also Habib et al., 2017; Kucikova et al., 2021). Although the medial temporal lobes, in particular the hippocampus, appear to also be involved in certain semantic memory tasks (for a review see Duff et al. 2020), consistent with recent work that observed a neuroanatomical overlap between the semantic network and the episodic recollection memory (Binder & Desai, 2011; Irish et al., 2016; Renoult et al., 2019), they may not support all types of personal and general knowledge (Renoult et al., 2012; Grilli & Verfallie, 2014; Martinelli et al., 2013).

Our results also suggest that healthy older adults retain the gist of their personal experience (Greene & Naveh-Benjamin, 2020, 2022, 2023, 2024; see also Sacripante et al., 2019, 2023a), as memory for the gist of events is forgotten at a slower rate in time as compared to memory for more specific details (Brainerd & Reyna, 2015; Conway et al., 1991; Murphy & Shapiro, 1994; Reyna & Brainerd, 1995; Sachs, 1967; Sacripante et al., 2023b; Sekeres et al., 2016; Thorndyke, 1977) and this could naturally make older adults' autobiographical narratives more focused on gist and therefore accentuate the elaboration of semantic details over time (Spreng et al., 2018; Lifanov et al., 2021). In our study, the performance from the $\epsilon 4$ carriers' group indeed suggests that the semanticization of their autobiographical narratives is robust and less sensitive to increased genetic risk for AD as opposed to episodic memory.

The present study however presents with some caveats. Firstly, the probed life chapters were not equally balanced across the three interview protocols, with participants being asked

to recall specific events and personal life chapters from last year and 10 years ago on the AI and PSAI, while on the GSAI general knowledge of culturally shared events was probed for last year only. This limited the relevance of comparison of target count details between the GSAI, for which the number of details was significantly lower than in the two other interviews. Nonetheless, when proportional scores were used instead, these scores did not differ between the GSAI and the AI (see Chapter 5). Although count and proportional scores are not directly interchangeable (see Lockrow et al., 2024), they can both still provide a helpful complimentary view of the data patterns. Furthermore, as noted by Melega et al. (2024), the GSAI was always administered at the end of the testing session, and this could have influenced the number of count details in this section of the interview, likely due to participants' fatigue, which is not uncommon among healthy older adults, especially in prolonged interview protocols like the ones we adopted.

Another evident caveat of this study can be found in the very limited number of homozygotes $\epsilon 4$ carriers included in our sample, which were only two. The $\epsilon 4$ allelic variation is not particularly common in the general population (i.e., roughly 20-25%, Caselli & Reiman, 2012) and therefore even rarer for homozygotes $\epsilon 4$, though more of these participants would have allowed us to further explore whether the nuanced impairment in episodic specificity could have been *APOE* $\epsilon 4$ dose-dependent, as demonstrated in previous studies (Blacker et al., 1997; Davidson et al., 2006).

Lastly, another potential methodological limitation of our experimental paradigm sits with the subjectivity in scoring autobiographical memory events that inevitably might have affected the processing and interpretation of the data for all the interview protocols involved. Although we reported high inter-rater reliability between raters, it is worth noting that the manual scoring of autobiographical interviews has recently been replaced by automated scoring via natural language processing (see van Genugten & Schacter, 2023; Klus et al., 2024). It is

therefore quite likely that future research looking at autobiographical memory will quickly endorse automated scoring processing as a more time-effective and objective method for data processing (see also Martinez, 2024).

Conclusions

Episodic specificity is selectively reduced in healthy older with increased genetic risk of developing AD for both on-task and off-task episodic details as measured by well-established and novel interview protocols assessing autobiographical memory. These results were also corroborated by significantly lower performance in a test of word recognition memory among carriers. Nonetheless, carriers and non-carriers showed similar semantic memory production for on-task general and personal semantic details on the SAI as well as off-task semantic details in the AI.

This pattern of results indicates that the amount of episodic impairment in *APOE* ϵ 4 carriers could be nuanced due to subtle differences in narrative abilities and sensitive to genetic risk for AD. Our findings are also consistent with the notion that healthy older ϵ 4 carriers retain the gist of their personal experience, and that their autobiographical narratives undergo a process of semanticization that makes their semantic memories more robust and less sensitive to increased genetic risk for AD as opposed to their episodic memories.

References

Acevedo-Molina, M. C., Matijevic, S., & Grilli, M. D. (2020). Beyond episodic remembering: Elaborative retrieval of lifetime periods in young and older adults. *Memory*, 28(1), 83-93. <https://doi.org/10.1080/09658211.2019.1686152>

Acevedo-Molina, M. C., Thayer, S. C., Horn, K., Nkulu, H., Ryan, L., Andrews-Hanna, J. R., & Grilli, M. D. (2023). Past and future episodic detail retrieval is reduced among clinically normal older adults at higher genetic risk for late-onset Alzheimer's disease. *Neuropsychology*, 37(2), 194 –203. <https://doi.org/10.1037/neu0000866>

Addis, D. R., & Tippett, L. (2004). Memory of myself: Autobiographical memory and identity in Alzheimer's disease. *Memory*, 12(1), 56-74. <https://doi.org/10.1080/09658210244000423>

Addis, D. R., Wong, A. T., & Schacter, D. L. (2008). Age-related changes in the episodic simulation of future events. *Psychological Science*, 19(1), 33–41. <https://doi:10.1111/j.1467-9280.2008.02043.x>

Addis, D. R., Sacchetti, D. C., Ally, B. A., Budson, A. E., & Schacter, D. L. (2009). Episodic simulation of future events is impaired in mild Alzheimer's disease. *Neuropsychologia*, 47(12), 2660–2671. <https://doi:10.1016/j.neuropsychologia.2009.05.018>

Aizpurua, A., & Koutstaal, W. (2015). A matter of focus: Detailed memory in the intentional autobiographical recall of older and younger adults. *Consciousness and Cognition*, 33, 145–155. <https://doi:10.1016/j.concog.2014.12.006>

Amer, T., Anderson, J. A., Campbell, K. L., Hasher, L., & Grady, C. L. (2016). Age differences in the neural correlates of distraction regulation: A network interaction approach. *Neuroimage*, 139, 231-239. <https://doi.org/10.1016/j.neuroimage.2016.06.036>

Amer, T., Giovanello, K. S., Grady, C. L., & Hasher, L. (2018). Age differences in memory for meaningful and arbitrary associations: A memory retrieval account. *Psychology and Aging*, 33(1), 74-81. <https://dx.doi.org/10.1037/pag0000220>

Amer, T., Giovanello, K. S., Nichol, D. R., Hasher, L., & Grady, C. L. (2019). Neural correlates of enhanced memory for meaningful associations with age. *Cerebral Cortex*, 29(11), 4568–4579. <https://doi.org/10.1093/cercor/bhy334>

Amer, T., Wynn, J. S., & Hasher, L. (2022). Cluttered memory representations shape cognition in old age. *Trends in Cognitive Sciences*, 26(3), 255–267. <https://doi.org/10.1016/j.tics.2021.12.002>

Barnabe, A., Whitehead, V., Pilon, R., Arsenault-Lapierre, G., & Chertkow, H. (2012). Autobiographical memory in mild cognitive impairment and Alzheimer's disease: A comparison between the Levine and Kopelman interview methodologies. *Hippocampus*, 22(9), 1809–1825. <https://doi.org/10.1002/hipo.22015>

Barnier, A. J., Priddis, A. C., Broekhuijse, J. M., Harris, C. B., Cox, R. E., Addis, D. R., Keil, P. G., & Congleton, A. R. (2014). Reaping what they sow: Benefits of remembering together in intimate couples. *Journal of Applied Research in Memory and Cognition*, 3(4), 261–265. <https://doi.org/10.1016/j.jarmac.2014.06.003>

Barry, T. J., Gregory, J. D., Latorre, J. M., Ros, L., Nieto, M., & Ricarte, J. J. (2021). A multi-method comparison of autobiographical memory impairments amongst younger and older adults. *Aging & Mental Health*, 25(5), 856-863. <https://doi.org/10.1080/13607863.2020.1729338>

Bastin, C., Feyers, D., Jedidi, H., Bahri, M. A., Degueldre, C., Lemaire, C., Collette, F., & Salmon, E. (2013). Episodic autobiographical memory in amnesic mild cognitive

impairment: What are the neural correlates? *Human Brain Mapping*, 34(8), 1811–1825.
<https://doi.org/10.1002/hbm.22032>

Benjamin, M. J., Cifelli, A., Garrard, P., Caine, D., & Jones, F. W. (2015). The role of working memory and verbal fluency in autobiographical memory in early Alzheimer's disease and matched controls. *Neuropsychologia*, 78, 115–121.
<https://doi.org/10.1016/j.neuropsychologia.2015.10.006>

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society: Series B (Methodological)*, 57(1), 289–300. <https://doi.org/10.1111/j.2517-6161.1995.tb02031.x>

Blacker, D., Haines, J. L., Rodes, L., Terwedow, H., Go, R. C. P., Harrell, L. E., ... & Tanzi, R. (1997). APOE-4 and age at onset of Alzheimer's disease: the NIMH genetics initiative. *Neurology*, 48(1), 139–147. <https://doi.org/10.1212/WNL.48.1.139>

Bluck, S., Alea, N., Baron-Lee, J. M., & Davis, D. K. (2016). Story asides as a useful construct in examining adults' story recall. *Psychology and Aging*, 31(1), 42–57.
<https://doi.org/10.1037/a0039990>

Borgaonkar, D., Schmidt, L., Martin, S. E., Kanzer, M., Edelsohn, L., Growdon, J., & Farrer, L. (1993). Linkage of late-onset Alzheimer's disease with apolipoprotein E type 4 on chromosome 19. *Lancet*, 342(8871), 625–625. [https://doi.org/10.1016/0140-6736\(93\)91458-x](https://doi.org/10.1016/0140-6736(93)91458-x)

Brainerd, C. J., & Reyna, V. F. (2015). Fuzzy-trace theory and lifespan cognitive development. *Developmental Review*, 38, 89–121. <https://doi.org/10.1016/j.dr.2015.07.006>

Buckley, R. F., Saling, M. M., Irish, M., Ames, D., Rowe, C. C., Villemagne, V. L., ... & Ellis, K. A. (2014). Autobiographical narratives relate to Alzheimer's disease biomarkers in

older adults. *International Psychogeriatrics*, 26(10), 1737-1746.
<https://doi.org/10.1017/S1041610214001136>

Buyse, D. J., Reynolds, C. F., III, Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, 28(2), 193–213. [https://doi.org/10.1016/0165-1781\(89\)90047-4](https://doi.org/10.1016/0165-1781(89)90047-4)

Cao, X., Madore, K. P., Wang, D., & Schacter, D. L. (2018). Remembering the past and imagining the future: attachment effects on production of episodic details in close relationships. *Memory*, 26(8), 1140-1150. <https://doi.org/10.1080/09658211.2018.1434800>

Caselli, R. J., & Reiman, E. M. (2012). Characterizing the preclinical stages of Alzheimer's disease and the prospect of presymptomatic intervention. *Journal of Alzheimer's Disease*, 33(s1), S405-S416. <https://doi.org/10.3233/JAD-2012-129026>

Chasles, M. J., Tremblay, A., Escudier, F., Lajeunesse, A., Benoit, S., Langlois, R., ... & Rouleau, I. (2020). An examination of semantic impairment in amnesic MCI and AD: What can we learn from verbal fluency?. *Archives of Clinical Neuropsychology*, 35(1), 22-30. <https://doi.org/10.1093/arclin/acz018>

Coelho, S., Guerreiro, M., Chester, C., Silva, D., Maroco, J., Paglieri, F., & de Mendonça, A. (2019). Mental time travel in mild cognitive impairment. *Journal of Clinical and Experimental Neuropsychology*, 41(8), 845–855. <https://doi.org/10.1080/13803395.2019.1632269>

Conway, M. A., Cohen, G., & Stanhope, N. (1991). On the very long-term retention of knowledge acquired through formal education: Twelve years of cognitive psychology. *Journal of Experimental Psychology: General*, 120(4), 395-409. <https://doi.org/10.1037/0096-3445.120.4.395>

Corder, E. H., Saunders, A. M., Strittmatter, W. J., Schmechel, D. E., Gaskell, P. C., Small, G., Roses, J.L., Haines, M.A., & Pericak-Vance, M. A. (1993). Gene dose of apolipoprotein E type 4 allele and the risk of Alzheimer's disease in late onset families. *Science*, 261(5123), 921-923. <https://doi:10.1126/science.8346443>

Davidson, Y., Gibbons, L., Pritchard, A., Hardicre, J., Wren, J., Stopford, C., ... & Mann, D. M. (2006). Apolipoprotein E ϵ 4 allele frequency and age at onset of Alzheimer's disease. *Dementia and Geriatric Cognitive Disorders*, 23(1), 60-66. <https://doi.org/10.1159/000097038>

De Brigard, F., Rodriguez, D. C., & Montañés, P. (2017). Exploring the experience of episodic past, future, and counterfactual thinking in younger and older adults: A study of a Colombian sample. *Consciousness and Cognition*, 51, 258-267. <https://doi.org/10.1016/j.concog.2017.04.007>

Devitt, A. L., Addis, D. R., & Schacter, D. L. (2017). Episodic and semantic content of memory and imagination: A multilevel analysis. *Memory & Cognition*, 45, 1078-1094. <https://doi.org/10.3758/s13421-017-0716-1>

Diamond, N. B., Abdi, H., & Levine, B. (2020). Different patterns of recollection for matched real-world and laboratory-based episodes in younger and older adults. *Cognition*, 202, 104309. <https://doi:10.1016/j.cognition.2020.104309>

Dritschel, B. H., Williams, J. M. G., Baddeley, A. D., & Nimmo-Smith, I. (1992). Autobiographical fluency: A method for the study of personal memory. *Memory & Cognition*, 20, 133-140. <https://doi.org/10.3758/BF03197162>

Duchek, J. M., Balota, D. A., & Cortese, M. (2006). Prospective memory and apolipoprotein E in healthy aging and early stage Alzheimer's disease. *Neuropsychology*, 20(6), 633–644. <https://doi.org/10.1037/0894-4105.20.6.633>

Duval, C., Desgranges, B., de La Sayette, V., Belliard, S., Eustache, F., & Piolino, P. (2012). What happens to personal identity when semantic knowledge degrades? A study of the self and autobiographical memory in semantic dementia. *Neuropsychologia*, 50(2), 254-265. <https://doi.org/10.1016/j.neuropsychologia.2011.11.019>

Eich, T. S., Tsapanou, A., & Stern, Y. (2019). When time's arrow doesn't bend: APOE- ϵ 4 influences episodic memory before old age. *Neuropsychologia*, 133, 107180. <https://doi.org/10.1016/j.neuropsychologia.2019.107180>

Ford, J. H., Rubin, D. C., & Giovanello, K. S. (2014). Effects of task instruction on autobiographical memory specificity in young and older adults. *Memory*, 22(6), 722-736. <https://doi.org/10.1080/09658211.2013.820325>

Ford, J., Zheng, B., Hurtado, B., de Jager, C. A., Udeh-Momoh, C., Middleton, L., & Price, G. (2020). Strategy or symptom: Semantic clustering and risk of Alzheimer's disease-related impairment. *Journal of Clinical and Experimental Neuropsychology*, 42(8), 849-856. <https://doi.org/10.1080/13803395.2020.1819964>

Fortea, J., Pegueroles, J., Alcolea, D., Belbin, O., Dols-Icardo, O., Vaqué-Alcázar, L., Gispert, J.D., Suarez-Calvet, M., Johnson, S.C., Sperling, R., Bejanin, A., Lleó, A., & Montal, V. (2024). APOE4 homozygosity represents a distinct genetic form of Alzheimer's disease. *Nature medicine*, 30, 1284–1291. <https://doi.org/10.1038/s41591-024-02931-w>

Gaesser, B., Sacchetti, D. C., Addis, D. R., & Schacter, D. L. (2011). Characterizing age-related changes in remembering the past and imagining the future. *Psychology and Aging*, 26(1), 80–84. <https://doi.org/10.1037/a0021054>

Gamboz, N., De Vito, S., Brandimonte, M. A., Pappalardo, S., Galeone, F., Iavarone, A., & Della Sala, S. (2010). Episodic future thinking in amnesic mild cognitive impairment. *Neuropsychologia*, 48(7), 2091-2097. <https://doi.org/10.1016/j.neuropsychologia.2010.03.030>

Grilli, M. D., Wank, A. A., Bercel, J. J., & Ryan, L. (2018). Evidence for reduced autobiographical memory episodic specificity in cognitively normal middle-aged and older individuals at increased risk for Alzheimer's disease dementia. *Journal of the International Neuropsychological Society*, 24(10), 1073-1083. <https://doi.org/10.1017/S1355617718000577>

Grilli, M. D., Wank, A. A., Huentelman, M. J., & Ryan, L. (2021). Autobiographical memory fluency reductions in cognitively unimpaired middle-aged and older adults at increased risk for Alzheimer's disease dementia. *Journal of the International Neuropsychological Society*, 27(9), 905-915. <https://doi.org/10.1017/S1355617720001319>

Grilli, M. D., & Sheldon, S. (2022). Autobiographical event memory and aging: Older adults get the gist. *Trends in Cognitive Sciences*, 26(12), 1079-1089. <https://10.1016/j.tics.2022.09.007>

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. *Psychology of Learning and Motivation*, 22, 193-225. [https://doi.org/10.1016/S0079-7421\(08\)60041-9](https://doi.org/10.1016/S0079-7421(08)60041-9)

Helkala, E. L., Koivisto, K., Hänninen, T., Vanhanen, M., Kervinen, K., Kuusisto, J., ... & Riekkinen Sr, P. (1995). The association of apolipoprotein E polymorphism with memory: a population based study. *Neuroscience Letters*, 191(3), 141-144. [https://doi.org/10.1016/0304-3940\(95\)11575-H](https://doi.org/10.1016/0304-3940(95)11575-H)

Hsieh, S., Schubert, S., Hoon, C., Mioshi, E., & Hodges, J. R. (2013). Validation of the Addenbrooke's Cognitive Examination III in frontotemporal dementia and Alzheimer's disease. *Dementia and geriatric cognitive disorders*, 36(3-4), 242-250. <https://doi.org/10.1159/000351671>

Irish, M. (2023). Autobiographical memory in dementia syndromes—An integrative review. *Wiley Interdisciplinary Reviews: Cognitive Science*, 14(3), e1630. <https://doi.org/10.1002/wcs.1630>

Irish, M., Lawlor, B. A., O'Mara, S. M., & Coen, R. F. (2011). Impaired capacity for autooietic reliving during autobiographical event recall in mild Alzheimer's disease. *Cortex*, 47(2), 236-249. <https://doi.org/10.1016/j.cortex.2010.01.002>

Irish, M., Addis, D. R., Hodges, J. R., & Piguet, O. (2012). Exploring the content and quality of episodic future simulations in semantic dementia. *Neuropsychologia*, 50(14), 3488-3495. <https://doi.org/10.1016/j.neuropsychologia.2012.09.012>

Irish, M., Landin-Romero, R., Mothakunnel, A., Ramanan, S., Hsieh, S., Hodges, J. R., & Piguet, O. (2018). Evolution of autobiographical memory impairments in Alzheimer's disease and frontotemporal dementia—A longitudinal neuroimaging study. *Neuropsychologia*, 110, 14-25. <https://doi.org/10.1016/j.neuropsychologia.2017.03.014>

James, L. E., Burke, D. M., Austin, A., & Hulme, E. (1998). Production and perception of “verbosity” in younger and older adults. *Psychology and Aging*, 13(3), 355–367. <https://doi.org/10.1037/0882-7974.13.3.355>

Joubert, S., Brambati, S. M., Ansado, J., Barbeau, E. J., Felician, O., Didic, M., ... & Kergoat, M. J. (2010). The cognitive and neural expression of semantic memory impairment in mild cognitive impairment and early Alzheimer's disease. *Neuropsychologia*, 48(4), 978-988. <https://doi.org/10.1016/j.neuropsychologia.2009.11.019>

Joubert, S., Gardy, L., Didic, M., Rouleau, I., & Barbeau, E. J. (2021). A meta-analysis of semantic memory in mild cognitive impairment. *Neuropsychology Review*, 31, 221-232. <https://doi.org/10.1007/s11065-020-09453-5>

Klus, J., Cohen, D. E., Garcia, A. N., Mehl, M. R., Andrews-Hanna, J. R., Grilli, M. D. (2024). *Modeling Memories, Predicting Prospections: Automated Scoring of Autobiographical Detail Narration using Large Language Models*. PsyArXiv. <https://doi.org/10.31234/osf.io/n7cvq>

Kroenke, K., Spitzer, R. L., & Williams, J.B.(2001).ThePHQ-9:Validityof a brief depression severity measure. *Journal of General Internal Medicine*, 16(9), 606–613. <https://doi.org/10.1046/j.1525-1497.2001.016009606.x>

Lambon Ralph, M. A, Jefferies, E., Patterson, K., & Rogers, T. T. (2017). The neural and computational bases of semantic cognition. *Nature Reviews Neuroscience*, 18(1), 42-55. <https://doi.org/10.1038/nrn.2016.150>

Lenth, R. (2021). Emmeans: Estimated marginal means, aka least-squares means. <https://CRAN.R-project.org/package=emmeans>.

Levine, B. (2004). Autobiographical memory and the self in time: Brain lesion effects, functional neuroanatomy, and lifespan development. *Brain and Cognition*, 55(1), 54-68. [https://doi.org/10.1016/S0278-2626\(03\)00280-X](https://doi.org/10.1016/S0278-2626(03)00280-X)

Levine, B., Black, S. E., Cabeza, R., Sinden, M., McIntosh, A. R., Toth, J. P., ... & Stuss, D. T. (1998). Episodic memory and the self in a case of isolated retrograde amnesia. *Brain*, 121(10), 1951-1973. <https://doi.org/10.1093/brain/121.10.1951>

Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: dissociating episodic from semantic retrieval. *Psychology and Aging*, 17(4), 677–689. <https://doi.org/10.1037/0882-7974.17.4.677>

Lifanov, J., Linde-Domingo, J., & Wimber, M. (2021). Feature-specific reaction times reveal a semanticisation of memories over time and with repeated remembering. *Nature communications*, 12(1), 3177. <https://doi.org/10.1038/s41467-021-23288-5>

Lockrow, A. W., Setton, R., Spreng, K. A., Sheldon, S., Turner, G. R., & Spreng, R. N. (2024). Taking stock of the past: A psychometric evaluation of the Autobiographical Interview. *Behavior Research Methods*, 56(2), 1002-1038. <https://doi.org/10.3758/s13428-023-02080-x>

Madore, K. P., Gaesser, B., & Schacter, D. L. (2014). Constructive episodic simulation: dissociable effects of a specificity induction on remembering, imagining, and describing in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 40(3), 609–622. <https://10.1037/a0034885>

McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B. T., Jack Jr, C. R., Kawas, C. H., ... & Phelps, C. H. (2011). The diagnosis of dementia due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia*, 7(3), 263-269. <https://doi.org/10.1016/j.jalz.2011.03.005>

McKinnon, M. C., Nica, E. I., Sengdy, P., Kovacevic, N., Moscovitch, M., Freedman, M., ... & Levine, B. (2008). Autobiographical memory and patterns of brain atrophy in fronto-temporal lobar degeneration. *Journal of Cognitive Neuroscience*, 20(10), 1839-1853. <https://doi.org/10.1162/jocn.2008.20126>

McKinnon, M. C., Palombo, D. J., Nazarov, A., Kumar, N., Khuu, W., & Levine, B. (2015). Threat of death and autobiographical memory: A study of passengers from Flight AT236. *Clinical Psychological Science*, 3(4), 487–502. <https://doi.org/10.1177/216770261454228>

Melega, G., Lancelotte, F., Johnen, A.-K., Hornberger, M., Levine, B., & Renoult, L. (2024). Evoking episodic and semantic details with instructional manipulation during autobiographical recall. *Psychology and Aging*, 39(4), 378–390. <https://doi.org/10.1037/pag0000821>

Meulenbroek, O., Rijpkema, M., Kessels, R. P., Rikkert, M. G. O., & Fernández, G. (2010). Autobiographical memory retrieval in patients with Alzheimer's disease. *Neuroimage*, 53(1), 331-340. <https://doi.org/10.1016/j.neuroimage.2010.05.082>

Mioshi, E., Dawson, K., Mitchell, J., Arnold, R., & Hodges, J. R. (2006). The Addenbrooke's Cognitive Examination Revised (ACE-R): a brief cognitive test battery for dementia screening. *International Journal of Geriatric Psychiatry: A journal of the psychiatry of late life and allied sciences*, 21(11), 1078-1085. <https://doi.org/10.1002/gps.1610>

Murphy, G. L., & Shapiro, A. M. (1994). Forgetting of verbatim information in discourse. *Memory & Cognition*, 22, 85-94. <https://doi.org/10.3758/BF03202764>

Murphy, K. J., Troyer, A. K., Levine, B., & Moscovitch, M. (2008). Episodic, but not semantic, autobiographical memory is reduced in amnesic mild cognitive impairment. *Neuropsychologia*, 46(13), 3116-3123. <https://doi.org/10.1016/j.neuropsychologia.2008.07.004>

Greene, N. R., & Naveh-Benjamin, M. (2020). A specificity principle of memory: Evidence from aging and associative memory. *Psychological Science*, 31(3), 316-331. <https://doi.org/10.1177/0956797620901760>

Greene, N. R., & Naveh-Benjamin, M. (2022). Adult age differences in specific and gist associative episodic memory across short-and long-term retention intervals. *Psychology and Aging*, 37(6), 681-697. <https://doi.org/10.1037/pag0000701>

Greene, N. R., & Naveh-Benjamin, M. (2023). Forgetting of specific and gist visual associative episodic memory representations across time. *Psychonomic Bulletin & Review*, 30(4), 1484-1501. <https://doi.org/10.3758/s13423-023-02256-8>

Greene, N. R., & Naveh-Benjamin, M. (2024). The time course of encoding specific and gist episodic memory representations among young and older adults. *Journal of Experimental Psychology: General*, 153(6), 1671–1697. <https://doi.org/10.1037/xge0001589>

Nilsson, L. G., Bäckman, L., Erngrund, K., Nyberg, L., Adolfsson, R., Bucht, G., ... & Winblad, B. (1997). The Betula prospective cohort study: Memory, health, and aging. *Aging, Neuropsychology, and Cognition*, 4(1), 1-32. <https://doi.org/10.1080/13825589708256633>

O'Donoghue, M. C., Murphy, S. E., Zamboni, G., Nobre, A. C., & Mackay, C. E. (2018). APOE genotype and cognition in healthy individuals at risk of Alzheimer's disease: A review. *Cortex*, 104, 103-123. <https://doi.org/10.1016/j.cortex.2018.03.025>

Peters, S. L., Fan, C. L., & Sheldon, S. (2019). Episodic memory contributions to autobiographical memory and open-ended problem-solving specificity in younger and older adults. *Memory & Cognition*, 47, 1592-1605. <https://doi.org/10.3758/s13421-019-00953-1>

Piolino, P., Desgranges, B., Belliard, S., Matuszewski, V., Lalevée, C., De La Sayette, V., & Eustache, F. (2003). Autobiographical memory and autonoetic consciousness: triple dissociation in neurodegenerative diseases. *Brain*, 126(10), 2203-2219. <https://doi.org/10.1093/brain/awg222>

Piolino, P., Desgranges, B., Clarys, D., Guillery-Girard, B., Taconnat, L., Isingrini, M., & Eustache, F. (2006). Autobiographical memory, autonoetic consciousness, and self-perspective in aging. *Psychology and Aging*, 21(3), 510 –525. <https://doi.org/10.1037/0882-7974.21.3.510>

Reitan, R. M. (1958). Validity of the Trail Making Test as an indicator of organic brain damage. *Perceptual and Motor Skills*, 8(3), 271–276. <https://doi.org/10.2466/pms.1958.8.3.271>

Renoult, L., Davidson, P. S., Palombo, D. J., Moscovitch, M., & Levine, B. (2012). Personal semantics: at the crossroads of semantic and episodic memory. *Trends in Cognitive Sciences*, 16(11), 550-558. <https://doi.org/10.1016/j.tics.2012.09.003>

Renoult, L., Armson, M. J., Diamond, N. B., Fan, C. L., Jeyakumar, N., Levesque, L., Olivia, L., McKinnon, M., Papadopoulos, A., Selarka, D., St Jacques, P.L., & Levine, B. (2020). Classification of general and personal semantic details in the Autobiographical Interview. *Neuropsychologia*, 144, 107501. <https://doi.org/10.1016/j.neuropsychologia.2020.107501>

Reyna, V. F., & Brainerd, C. J. (1995). Fuzzy-trace theory: An interim synthesis. *Learning and individual Differences*, 7(1), 1-75. [https://doi.org/10.1016/1041-6080\(95\)90031-4](https://doi.org/10.1016/1041-6080(95)90031-4)

Robin, J., & Moscovitch, M. (2017). Familiar real-world spatial cues provide memory benefits in older and younger adults. *Psychology and Aging*, 32(3), 210–219. <https://doi.org/10.1037/pag0000162>

Ros, L., Romero, D., Ricarte, J. J., Serrano, J. P., Nieto, M., & Latorre, J. M. (2018). Measurement of overgeneral autobiographical memory: Psychometric properties of the autobiographical memory test in young and older populations. *PloS One*, 13(4), <https://doi.org/10.1371/journal.pone.0196073>

Ros, L., Latorre, J. M., & Serrano, J. P. (2009). Working memory capacity and overgeneral autobiographical memory in young and older adults. *Aging, Neuropsychology, and Cognition*, 17(1), 89-107. <https://doi.org/10.1080/13825580903042650>

Rosen, V. M., Sunderland, T., Levy, J., Harwell, A., McGee, L., Hammond, C., ... & Lefkowitz, C. (2005). Apolipoprotein E and category fluency: evidence for reduced semantic access in healthy normal controls at risk for developing Alzheimer's disease. *Neuropsychologia*, 43(4), 647-658. <https://doi.org/10.1016/j.neuropsychologia.2004.06.022>

Sachs, J. S. (1967). Recognition memory for syntactic and semantic aspects of connected discourse. *Perception & Psychophysics*, 2(9), 437-442. <https://doi.org/10.3758/BF03208784>

Sacripante, R., McIntosh, R. D., & Della Sala, S. (2019). Benefit of wakeful resting on gist and peripheral memory retrieval in healthy younger and older adults. *Neuroscience Letters*, 705, 27-32. <https://doi.org/10.1016/j.neulet.2019.04.026>

Sacripante, R., Girtler, N., Doglione, E., Nobili, F., & Della Sala, S. (2023a). Forgetting rates of prose memory in Mild Cognitive Impairment. *Journal of Alzheimer's Disease*, 91(4), 1385-1394. <https://doi.org/10.3233/JAD-220803>

Sacripante, R., Logie, R. H., Baddeley, A., & Della Sala, S. (2023b). Forgetting rates of gist and peripheral episodic details in prose recall. *Memory & Cognition*, 51(1), 71-86. <https://doi.org/10.3758/s13421-022-01310-5>

Sacripante, R., James, T., Hornberger, M., Blake, J., & Renoult, L. (2025). Semantic Memory in Healthy Apolipoprotein ε4 Carriers: A Systematic Review. *medRxiv*, 2025-03. <https://doi.org/10.1101/2025.03.07.25323557>

Salo, A., Ylikoski, R., Verkkoniemi, A., Polvikoski, T., Juva, K., Rastas, S., ... & Sulkava, R. (2001). Does apolipoprotein E influence learning and memory in the nondemented oldest old?. *International Psychogeriatrics*, 13(4), 451-459. <https://doi.org/10.1017/S1041610201007864>

Sekeres, M. J., Bonasia, K., St-Laurent, M., Pishdadian, S., Winocur, G., Grady, C., & Moscovitch, M. (2016). Recovering and preventing loss of detailed memory: differential rates of forgetting for detail types in episodic memory. *Learning & Memory*, 23(2), 72-82. <http://www.learnmem.org/cgi/doi/10.1101/lm.039057.115>

Sheldon, S., & Levine, B. (2015). The medial temporal lobes distinguish between within-item and item-context relations during autobiographical memory retrieval. *Hippocampus*, 25(12), 1577-1590.

Sheldon, S., Sheldon, J., Zhang, S., Setton, R., Turner, G. R., Spreng, R. N., & Grilli, M. D. (2024). Differences in the content and coherence of autobiographical memories between younger and older adults: Insights from text analysis. *Psychology and Aging*, 39(1), 59 –71. <https://doi.org/10.1037/pag0000769>

Simpson, S., Eskandaripour, M., & Levine, B. (2023). Effects of healthy and neuropathological aging on autobiographical memory: A meta-analysis of studies using the Autobiographical Interview. *The Journals of Gerontology: Series B*, 78(10), 1617-1624. <https://doi.org/10.1093/geronb/gbad077>

Small, B. J., Rosnick, C. B., Fratiglioni, L., & Bäckman, L. (2004). Apolipoprotein E and cognitive performance: a meta-analysis. *Psychology and Aging*, 19(4), 592-600. <https://doi.org/10.1037/0882-7974.19.4.592>

Spitzer, R. L., Kroenke, K., Williams, J. B., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of internal medicine*, 166(10), 1092-1097. <https://doi:10.1001/archinte.166.10.1092>

Spreng, R. N., Lockrow, A. W., DuPre, E., Setton, R., Spreng, K. A., & Turner, G. R. (2018). Semanticized autobiographical memory and the default–executive coupling hypothesis

of aging. *Neuropsychologia*, 110, 37-43.
<https://doi.org/10.1016/j.neuropsychologia.2017.06.009>

St. Jacques, P. L., & Levine, B. (2007). Ageing and autobiographical memory for emotional and neutral events. *Memory*, 15(2), 129-144.
<https://doi.org/10.1080/09658210601119762>

Storandt, M. (2008). Cognitive deficits in the early stages of Alzheimer's disease. *Current Directions in Psychological Science*, 17(3), 198-202. <https://doi.org/10.1111/j.1467-8721.2008.00574.x>

Taler, V., Voronchikhina, A., Gorfine, G., & Lukasik, M. (2016). Knowledge of semantic features in mild cognitive impairment. *Journal of Neurolinguistics*, 38, 56-70.
<https://doi.org/10.1016/j.jneuroling.2015.11.002>

Taler, V., Monetta, L., Sheppard, C., & Ohman, A. (2020). Semantic function in mild cognitive impairment. *Frontiers in Psychology*, 10, 3041.
<https://doi.org/10.3389/fpsyg.2019.03041>

Thorndyke, P. W. (1977). Cognitive structures in comprehension and memory of narrative discourse. *Cognitive Psychology*, 9(1), 77-110. [https://doi.org/10.1016/0010-0285\(77\)90005-6](https://doi.org/10.1016/0010-0285(77)90005-6)

Trunk, D. L., & Abrams, L. (2009). Do younger and older adults' communicative goals influence off-topic speech in autobiographical narratives? *Psychology and Aging*, 24(2), 324-337. <https://doi.org/10.1037/a0015259>

Tse, C. S., Balota, D. A., Moynan, S. C., Duchek, J. M., & Jacoby, L. L. (2010). The utility of placing recollection in opposition to familiarity in early discrimination of healthy

aging and very mild dementia of the Alzheimer's type. *Neuropsychology*, 24(1), 49 – 67. <https://doi.org/10.1037/a0014887>

Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology*, 53(1), 1–25. <https://doi.org/10.1146/annurev.psych.53.100901.135114>

van Genugten, R. D., & Schacter, D. L. (2024). Automated scoring of the autobiographical interview with natural language processing. *Behavior Research Methods*, 56(3), 2243-2259. <https://doi.org/10.3758/s13428-023-02145-x>

Wank, A. A., Andrews-Hanna, J. R., & Grilli, M. D. (2021). Searching for the past: Exploring the dynamics of direct and generative autobiographical memory reconstruction among young and cognitively normal older adults. *Memory & Cognition*, 49, 422-437. <https://doi.org/10.3758/s13421-020-01098-2>

Wardell, V., Esposito, C.L., Madan, C.R., & Palombo, D. J. (2021). Semi-automated transcription and scoring of autobiographical memory narratives. *Behavior Research Methods*, 53(2), 507–517. <https://doi.org/10.3758/s13428-020-01437-w>

Wechsler, D. (1987). *Wechsler Memory Scale–Revised*. Psychological Corporation.

Wikgren, M., Karlsson, T., Nilbrink, T., Nordfjäll, K., Hultdin, J., Slegers, K., ... & Norrback, K. F. (2012). APOE ϵ 4 is associated with longer telomeres, and longer telomeres among ϵ 4 carriers predicts worse episodic memory. *Neurobiology of Aging*, 33(2), 335-344. <https://doi.org/10.1016/j.neurobiolaging.2010.03.004>

Wilson, R. S., Bienias, J. L., Berry-Kravis, E., Evans, D. A., & Bennett, D. A. (2002). The apolipoprotein E ϵ 2 allele and decline in episodic memory. *Journal of Neurology, Neurosurgery & Psychiatry*, 73(6), 672-677. <https://doi.org/10.1136/jnnp.73.6.672>

Wisdom, N. M., Callahan, J. L., & Hawkins, K. A. (2011). The effects of apolipoprotein E on non-impaired cognitive functioning: a meta-analysis. *Neurobiology of Aging*, 32(1), 63-74. <https://doi.org/10.1016/j.neurobiolaging.2009.02.003>

Zavagnin, M., De Beni, R., Borella, E., & Carretti, B. (2016). Episodic future thinking: the role of working memory and inhibition on age-related differences. *Aging Clinical and Experimental Research*, 28, 109-119. <https://doi.org/10.1007/s40520-015-0368-6>

Chapter Five: Extended Methodology

DNA extraction and *APOE* Genotyping information

DNA was extracted according to the manufacturer's instructions using the Qiagen Buccal Swab Spin protocol (QIAamp DNA MiniKits, Qiagen, Hilden, Germany). AE buffer was used for the final elution step. In brief, the tips of the buccal swabs were combined with PBS, QIAGEN Protease stock and AL buffer and incubated at 56 °C for 10 minutes. After this, ethanol was added and the solution added to a QIAamp Mini spin collum and centrifuged. In subsequent steps Buffer AW1 and AW2 were added to the QIAamp Mini spin column and centrifuged. The recommended Step 9 where the QIAamp Mini spin collum is centrifuged again without additional buffer to avoid carryover was included. In a last step, DNA was eluted in Buffer AE.

DNA yield was measured through absorbance ratios (260/230 and 260/280) using the NanoDrop (NanoDrop™ 1000, Thermo Fisher Scientific, Waltham, MA, USA) and stored at -30°C until quantitative Polymerase Chain Reaction (qPCR) was performed. Genomic DNA was isolated and purified using the QIAamp DNA Mini Kit (QIAGEN). Extracted DNA was then quantified by a NanoDrop™ spectrophotometer (Thermo Fisher Scientific). Single-Nucleotide Polymorphism (SNP) *APOE* genotyping (rs429358 and rs7412) was performed using TaqMan® Predesigned SNP Genotyping Assays (Assay ID: C__3084793_20 and C__904973_10, Thermo Fisher Scientific) following manufacturer's instruction. Briefly, for each reaction, 2µL of DNA template containing 1–20 ng extracted DNA, 0.5µL of 20x Assay Working Stock, 5µL of 2x qPCRBIO Probe Mix Lo-ROX (PCR Biosystems), and 2.5µL UltraPure™ nuclease-free water (Thermo Fisher Scientific) were mixed to make up a total

volume of 10µL. Real-time qPCR and post-PCR analysis were carried out in an ABI 7500 Fast Real-Time PCR System (Applied Biosystem, Thermo Fisher Scientific).

Apolipoprotein E (*APOE*) has three predominant isoforms ($\epsilon 2$, $\epsilon 3$ and $\epsilon 4$) which are determined by two SNPs (rs429358 and rs7412). These two SNPs result in either cysteine or arginine at codons 112 and position 158 respectively (see *Table 1*). *APOE* genotypes are defined as per *Table 2*.

Table 1. APOE polymorphisms

<i>APOE</i> isoform	SNP		Amino acid	
	rs429358	rs7412	112	158
$\epsilon 2$	T	T	Cysteine	Cysteine
$\epsilon 3$	T	C	Cysteine	Arginine
$\epsilon 4$	C	C	Arginine	Arginine

Table 2. APOE genotypes

<i>APOE</i> genotype	rs429358	rs7412
$\epsilon 2/\epsilon 2$	T/T	T/T
$\epsilon 2/\epsilon 3$	T/T	C/T
$\epsilon 2/\epsilon 4$	C/T	C/T
$\epsilon 3/\epsilon 3$	T/T	C/C
$\epsilon 3/\epsilon 4$	C/T	C/C
$\epsilon 4/\epsilon 4$	C/C	C/C

Chapter Six: Additional Results

Correlations between internal details and recognition memory scores

To explore whether the neuropsychological tests and the subcomponents of the ACE-III (Attention, Memory, Fluency, Language, Visuospatial) correlated with internal details and external events produced in the original AI (both count and ratio scores), we computed both Pearson's r and Spearman's ρ coefficients (in case of a violation of the normality distribution assumption as assessed by Shapiro-Wilk test). Correlation coefficients and scatterplots were computed with JASP (University of Amsterdam, 0.16.2.0).

On the overall sample of participants including both carriers and non-carriers (see *Table 3*), there was a significant correlation between the count scores for internal details on the AI and the Attention component of the ACE-III ($\rho = .396, p = .021$). For the ratio scores for internal details on the AI, we observed a positive significant correlation with the Language component of the ACE-III ($\rho = .364, p = .034$) and a negative significant correlation with the Word Recognition accuracy index ($\rho = -0.352, p = 0.038$). In terms of external events, there was also a significant positive correlation between count scores of external events and the Word Recognition accuracy index ($\rho = .428, p = .010$).

When correlations were analysed for carriers only (see *Table 4*), count scores for internal details on the AI showed a significant positive correlation with the Visuospatial component of the ACE-III ($\rho = .604, p = .013$), while a negative correlation was observed between count scores of the external details on the AI and Fluency component of the ACE-III ($\rho = -.541, p = .042$). The Fluency component of the ACE-III showed also a positive correlation with ratio scores for internal details on the AI ($\rho = .516, p = .041$). In non-carriers

only (see *Table 5*), there was a significant correlation between count scores for internal details on the AI and the Attention component of the ACE-III ($\rho = .583, p = .011$). Instead, ratio scores on the AI negatively correlated with Word Recognition accuracy scores ($\rho = -.470, p = .049$).

Within-group rank-order correlations for count data

To establish whether carriers and non-carriers maintained their rank in the count of target details across interviews, we calculated within-group rank order correlations. Between the AI and the PSAI, within rank order approached significance for carriers ($\tau = 0.35, p = .07$) and were non-significant for non-carriers ($\tau = 0.10, p = .57$). The within-group correlations between the AI and the GSAI also approached significance for carriers ($\tau = 0.30, p = .08$), but were non-significant for non-carriers ($\tau = -0.01, p = .94$). Finally, correlations were non-significant for both groups when comparing the PSAI and the GSAI (carriers: $\tau = 0.21, p = .22$, non-carriers: $\tau = 0.20, p = .23$). These results showed a moderate intra-individual consistency for carriers in interviews evoking episodic and personal semantic details, as well as in interviews evoking episodic and general semantic details.

Within-group rank-order correlations for ratio data

For ratio data, within-group rank order correlations revealed that, between the AI and the PSAI, correlations were non-significant for carriers ($\tau = 0.17, p = 0.32$) and non-carriers ($\tau = 0.04, p = 0.83$). The within-group correlations between the AI and GSAI were marginally significant for carriers ($\tau = 0.32, p = 0.054$) and non-significant for non-carriers ($\tau = 0.06, p = 0.72$). Between the PSAI and the GSAI, correlations were also non-significant for both carriers ($\tau = 0.23, p = 0.17$) and non-carriers ($\tau = 0.20, p = 0.23$).

***APOE* group differences in detail elaboration in each interview**

As for count details, we here also provide a fine-grain analysis of the production of detail categories across the three interviews with proportional scores. Average proportional scores on each detail category can be found in *Table 6*.

Table 4. Proportional scores in Carriers and Non- carriers for cumulative recall (Free Recall, General Probe, and Specific Probe) in the AI, PSAI, and GSAI

Detail type	AI		PSAI		GSAI	
	Carriers	Non-carriers	Carriers	Non-carriers	Carriers	Non-carriers
Internal details	0.48 (0.12)	0.45 (0.09)	-	-	-	-
External events	0.29 (0.07)	0.30 (0.05)	0.01 (0.01)	0.01 (0.01)	0.02 (0.03)	0.02 (0.03)
Autobio Facts	0.03 (0.05)	0.04 (0.02)	0.42 (0.04)	0.41 (0.06)	0.07 (0.04)	0.05 (0.08)
Self Knowledge	0.01 (0.01)	0.01 (0.01)	0.20 (0.05)	0.20 (0.06)	0.27 (0.13)	0.22 (0.13)
Repeated Events	0.00 (0.00)	0.00 (0.00)	0.14 (0.05)	0.13 (0.03)	0.00 (0.01)	0.00 (0.01)
General Semantic	0.01 (0.02)	0.02 (0.02)	0.03 (0.02)	0.03 (0.02)	0.42 (0.14)	0.46 (0.16)
Repetitions	0.07 (0.03)	0.08 (0.03)	0.08 (0.04)	0.08 (0.03)	0.04 (0.03)	0.05 (0.04)
Other	0.09 (0.04)	0.09 (0.02)	0.10 (0.03)	0.11 (0.05)	0.15 (0.10)	0.16 (0.11)

Autobiographical Interview

Average proportional scores on the original AI are illustrated in *Figure 1*. ANOVA revealed a significant main effect of detail type, $F(7,288) = 415.414$, $\eta^2_p = 0.91$, 95% CI [0.90, 1.00], $p < .0001$, which means that both carriers and non-carriers produced different proportions across factors levels (i.e., different categories of details). Post-hoc pairwise tests were carried out and revealed that the overall group of participants produced a greater proportion of target details (i.e., internal details) as compared to all other detail categories (External events: $p < .0001$, Autobiographical Facts: $p < .0001$, Self-Knowledge: $p < .0001$, Repeated Events: $p < .0001$, General Semantic: $p < .0001$, Repetitions: $p < .0001$, Other: $p < .0001$). Interestingly, participants also produced a greater proportion of external events as compared to all other detail categories (Autobiographical Facts: $p < .0001$, Self-Knowledge: $p < .0001$, Repeated Events: $p < .0001$, General Semantic: $p < .0001$, Repetitions: $p < .0001$, Other: $p < .0001$), apart from internal details. These comparisons overall suggest that participants were on task, given their higher scores on target internal details.

There was also a non-significant main effect of group, $F(1,288) = 0.00$, $\eta^2_p = 0.00$, 95% CI [0.00,1.00], $p = 1.00$. Both carriers and non-carriers overall produced a similar rate of internal details and external events, as seen by the lack of interaction between detail type and Group, $F(7,288) = 0.751$, $\eta^2_p = 0.02$, 95% CI [0.00, 1.00], $p = .628$

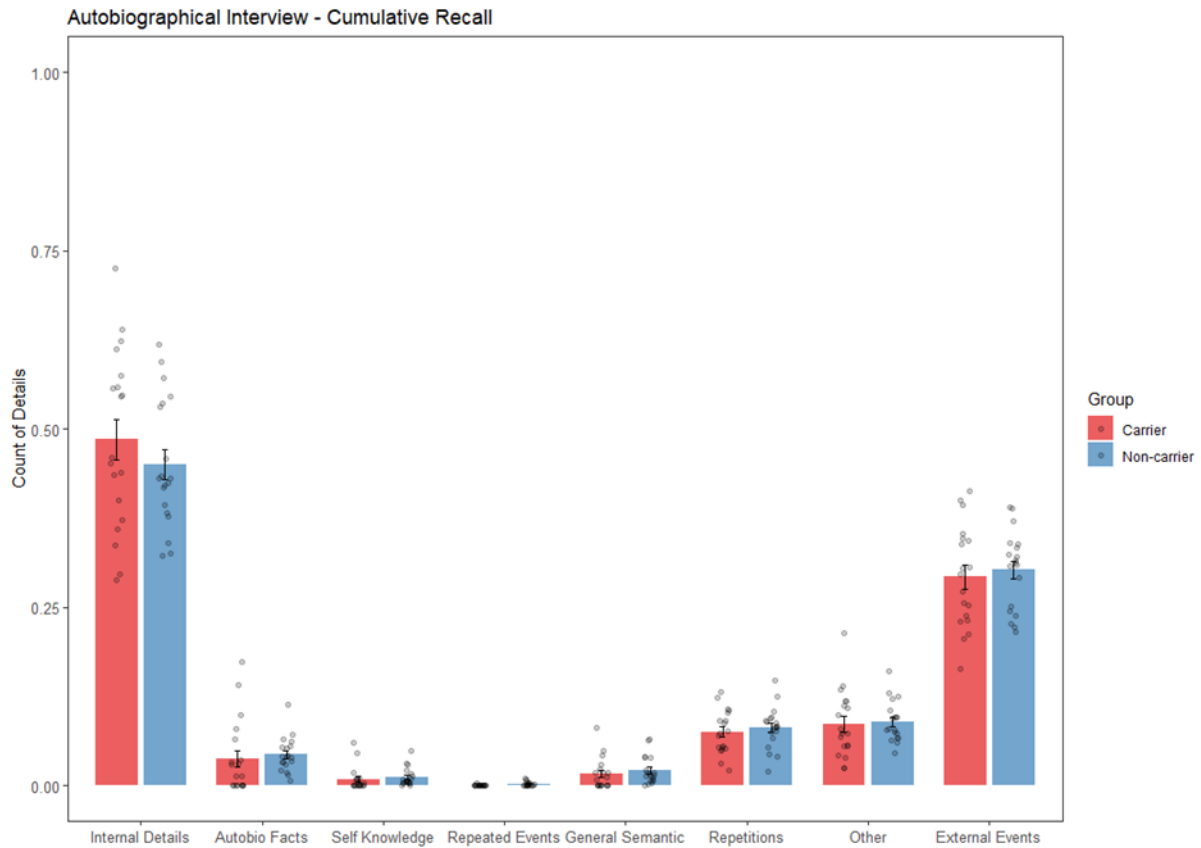


Figure 1. Proportions of detail types during cumulative recall in the Carrier and Non-carrier group in the original AI.

Personal Semantic Interview

When analysing the proportional data of the subtypes of details produced in the PSAI (see Figure 2), there was again only a main effect of detail type, $F(6,252) = 388.104$, $\eta^2_p = 0.90$, 95% CI [0.89, 1.00], $p < .0001$), as participants in both groups produced different proportional scores across categories of details. Post-hoc pairwise tests showed that the overall group of participants produced a greater proportion of Autobiographical Facts as compared to any other category of details (External events: $p < .0001$, Self-Knowledge: $p < .0001$, Repeated Events: $p < .0001$, General Semantic: $p < .0001$, Repetitions: $p < .0001$, Other: $p < .0001$).

Also, the overall group produced a higher proportion of Self-Knowledge details compared to any other detail categories (External events: $p < .0001$, Repeated Events: $p < .0001$, General Semantic: $p < .0001$, Repetitions: $p < .0001$, Other: $p < .0001$) except for Autobiographical Facts. Finally, participants proportionally produced more Repeated Events details than External Events ($p < .0001$), General Semantic ($p < .0001$) and Repetitions ($p < .0001$). These findings suggest that participants were overall on task, as seen by their proportional scores in target details such as Autobiographical Facts, Self-Knowledge and partly also Repeated Events.

There was also a non-significant main effect of group, $F(1,252) = 0.000$, $\eta^2_p = 0.00$, 95% CI [0.00, 1.00], $p = 1.00$. The interaction between detail type and Group was not significant, $F(6,252) = 0.344$, $\eta^2_p = 0.00$, 95% CI [0.00, 1.00], $p = .918$. This broadly indicates that both carriers and non-carriers were equally on task in their semantic production for personally relevant events.

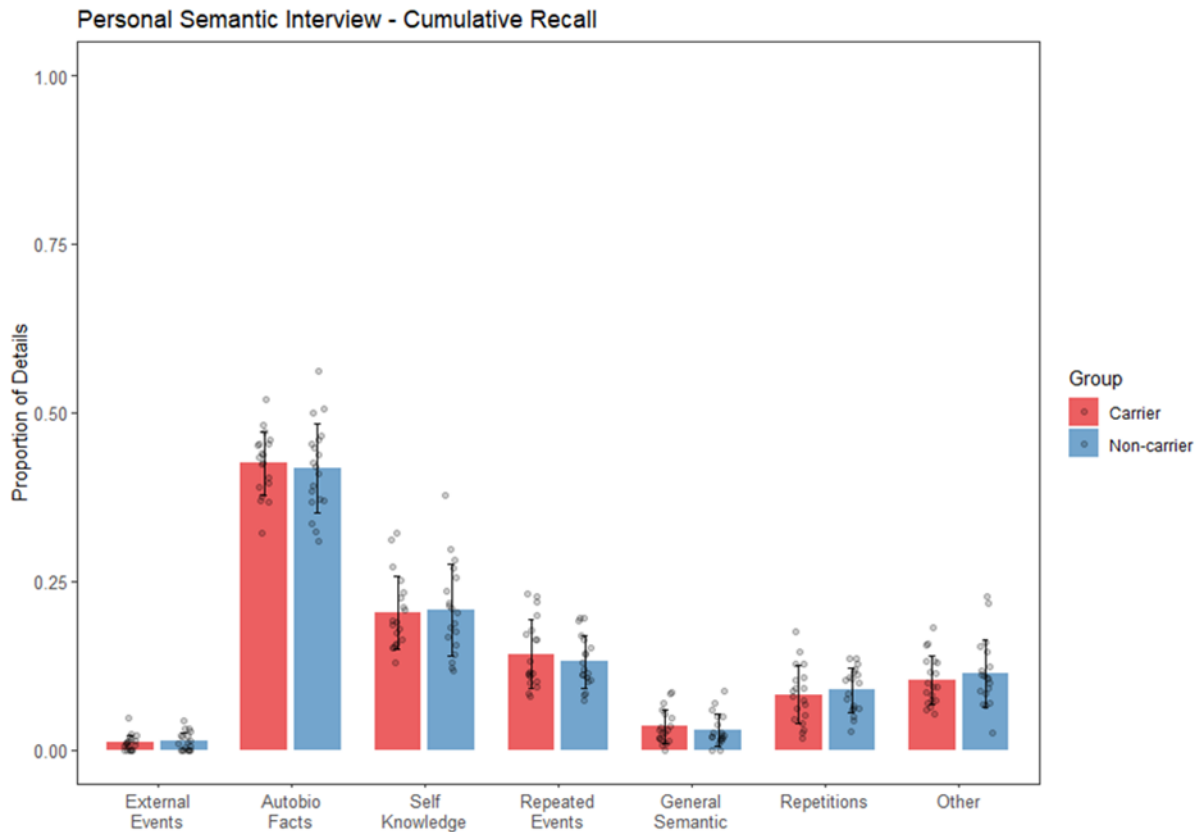


Figure 2. Count of detail types during cumulative recall in the Carrier and Non-carrier group in the PSAI.

General Semantic Interview

Average proportional scores on the different subtypes of details are illustrated in Figure 3. Once again, ANOVA only revealed a main effect on detail type, $F(6,252) = 110.609$, $\eta^2_p = 0.72$, 95% CI [0.68, 1.00], $p < .0001$, since participants in both groups produced different proportional scores across categories of details. Post-hoc pairwise tests were carried out and revealed that the overall group of participants produced a greater proportion of general semantic details as compared to any other detail categories (External events: $p < .0001$, Autobiographical Facts: $p < .0001$, Self-Knowledge: $p < .0001$, Repeated Events: $p < .0001$, General Semantic: $p < .0001$, Repetitions: $p < .0001$, Other: $p < .0001$). Interestingly, participants also produced a greater proportion of Self-Knowledge details when compared to

all the other detail categories (External events, $p < .001$, Autobiographical Facts: $p < .0001$, Repeated Events: $p < .0001$, Repetitions: $p < .0001$, Other: $p < .001$), apart from general semantic details. These comparisons indicate that participants were overall on task, given the highest scores on target General Semantic details.

There was, however, a non-significant main effect of group, $F(1,252) = 0.00$, $\eta^2_p = 0.00$, 95% CI [0.00, 1.00], $p = 1.00$. The interaction between detail type and group was also non-significant, $F(6,252) = 0.037$, $\eta^2_p = 0.02$, 95% CI [0.00, 1.00], $p = 0.643$, which indicates that participants from both groups were proportionally both on-task in the production on internal general semantic details.

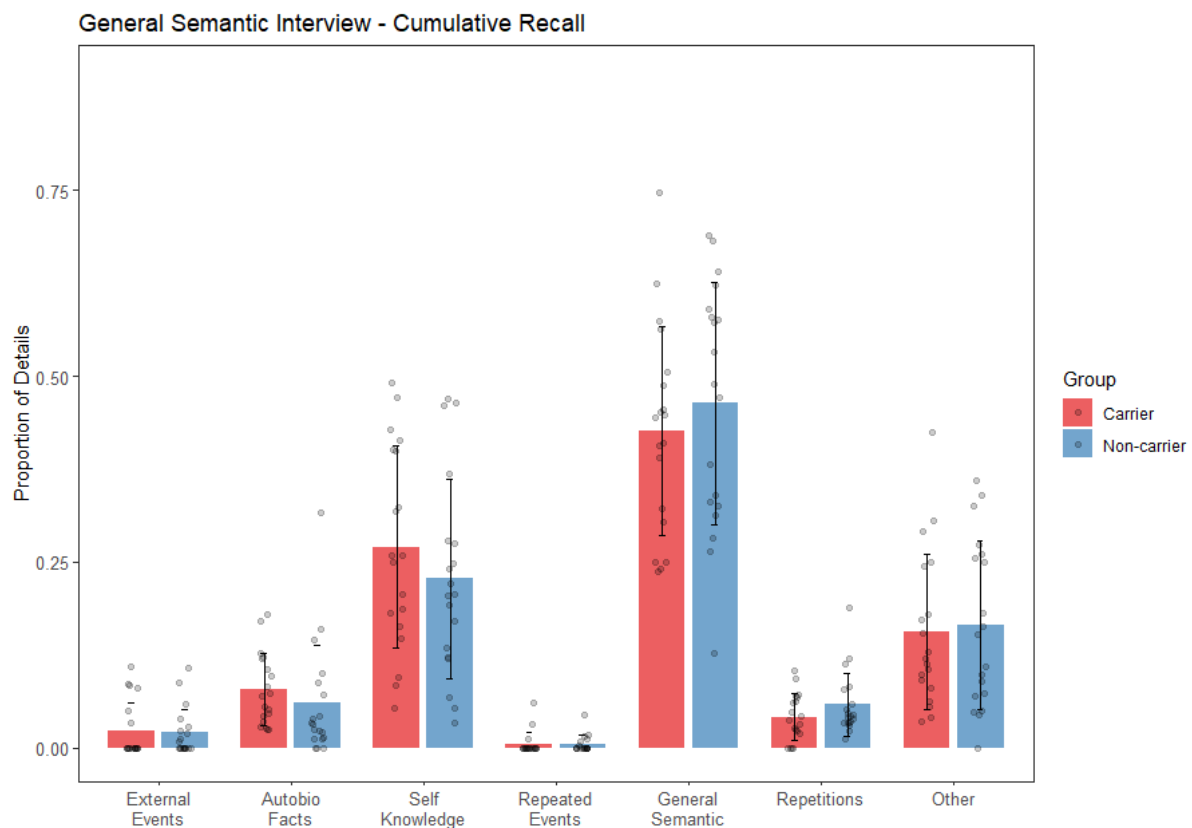


Figure 3. Proportions of detail types during cumulative recall in the Carrier and Non-carrier group in the GSAI.

Table 1. Correlation matrix between neuropsychological tests and count and ratios scores on the AI (internal details and external events) on the overall sample of participants.

Variable		Attention- ACE III	Memory- ACE III	Fluency- ACE III	Language- ACE III	Visuospatial ACE-III	ACE III Score	Digit Backwards	Trail A Time	Trail B Time	Word Recognition Accuracy	Source Accuracy	
Internal Count	Pearson's r	0.304	0.008	0.137	-0.007	0.286	0.237	-0.050	-0.025	-	0.058	0.117	-0.043
	p-value	0.081	0.963	0.441	0.969	0.101	0.170	0.779	0.885	0.742	0.503	0.807	
	Spearman's rho	0.396 *	0.055	0.061	-0.115	0.330	0.264	-0.002	-0.011	0.135	0.179	-0.042	
	p-value	0.021	0.759	0.731	0.519	0.056	0.125	0.989	0.949	0.439	0.303	0.811	
	Kendall's Tau B	0.309 *	0.062	0.044	-0.081	0.274	0.187	0.004	-0.002	0.096	0.132	-0.039	
	p-value	0.027	0.636	0.747	0.553	0.050	0.132	0.976	0.989	0.425	0.305	0.752	
Internal Ratio	Pearson's r	-0.009	-0.021	0.119	0.342 *	-0.204	-	-0.089	0.038	0.218	-	0.219	
	p-value	0.961	0.908	0.501	0.048	0.246	0.021	0.618	0.827	0.208	0.352 *	0.207	
	Spearman's rho	-0.077	-0.058	0.181	0.364 *	-0.211	-	-0.126	-0.029	0.068	-	0.222	
	p-value	0.665	0.745	0.306	0.034	0.231	0.019	0.478	0.867	0.697	0.358 *	0.201	
	Kendall's Tau B	-0.058	-0.044	0.135	0.277 *	-0.185	-	-0.081	-0.015	0.041	-	0.148	
	p-value	0.677	0.737	0.318	0.042	0.186	0.039	0.525	0.898	0.733	0.258 *	0.229	
External count	Pearson's r	0.111	0.167	0.020	-0.160	0.291	0.250	0.075	0.054	-	0.314	-0.226	
	p-value	0.533	0.345	0.911	0.365	0.095	0.148	0.675	0.759	0.114	0.066	0.191	
	Spearman's rho	0.148	0.018	-	-0.280	0.309	0.121	0.072	0.066	0.076	0.428 *	-0.210	
	p-value	0.403	0.918	0.993	0.109	0.075	0.487	0.686	0.707	0.665	0.010	0.225	

Variable		Attention- ACE III	Memory- ACE III	Fluency- ACE III	Language- ACE III	Visuospatial ACE-III	ACE III Score	Digit Backwards	Trail A Time	Trail B Time	Word Recognition Accuracy	Source Accuracy
External ratio	Kendall's Tau B	0.116	0.034	- 0.002	-0.216	0.253	0.098	0.054	0.034	0.053	0.331 **	-0.136
	p-value	0.405	0.795	0.987	0.113	0.071	0.430	0.672	0.776	0.659	0.010	0.270
	Pearson's r	-0.078	0.070	- 0.064	-0.218	0.186	0.064	0.097	-0.010	- 0.152	0.322	-0.267
	p-value	0.661	0.693	0.718	0.216	0.293	0.717	0.584	0.954	0.383	0.059	0.122
	Spearman's rho	-0.012	0.102	- 0.126	-0.191	0.159	0.043	0.132	0.025	- 0.022	0.309	-0.291
	p-value	0.949	0.566	0.479	0.279	0.369	0.805	0.456	0.889	0.901	0.071	0.090
	Kendall's Tau B	-0.018	0.071	- 0.096	-0.146	0.128	0.046	0.089	0.019	- 0.020	0.209	-0.215
	p-value	0.899	0.582	0.478	0.283	0.361	0.709	0.486	0.876	0.864	0.104	0.080

*statistically significant at $p = 0.05$

Table 2. Correlation matrix between neuropsychological tests and count and ratios scores on the AI (internal details and external events) for Carriers only.

Variable		Attention- ACE III	Memory- ACE III	Language- ACE III	Visuospatial ACE-III	Fluency- ACE III	ACE III Score	Digit Backwards	Trail A Time	Trail B Time	Word Recognition Accuracy	Source Accuracy
Internal Count	Pearson's r	0.195	0.153	0.145	0.492	-0.102	0.297	-0.125	-0.049	-0.004	0.062	-0.121
	p-value	0.468	0.571	0.593	0.053	0.707	0.247	0.644	0.851	0.989	0.813	0.645
	Spearman's rho	0.092	0.080	0.089	0.604 *	-0.249	0.336	-0.179	-0.027	0.185	0.072	-0.105
	p-value	0.733	0.767	0.744	0.013	0.353	0.187	0.507	0.918	0.476	0.783	0.689
	Kendall's Tau B	0.053	0.085	0.066	0.495 *	-0.195	0.221	-0.106	0.000	0.141	0.050	-0.084
	p-value	0.799	0.668	0.751	0.020	0.337	0.238	0.582	1.000	0.433	0.794	0.648
Internal Ratio	Pearson's r	-0.003	0.203	0.490	-0.065	0.450	0.155	-0.010	0.072	-0.040	-0.268	0.229
	p-value	0.993	0.450	0.054	0.812	0.080	0.553	0.971	0.782	0.878	0.299	0.377
	Spearman's rho	-0.023	0.226	0.519 *	0.161	0.516 *	0.230	-0.069	0.056	-0.082	-0.200	0.200
	p-value	0.932	0.401	0.039	0.552	0.041	0.374	0.801	0.830	0.754	0.442	0.442
	Kendall's Tau B	-0.011	0.161	0.399	0.121	0.370	0.142	-0.018	0.030	-0.052	-0.135	0.145
	p-value	0.959	0.419	0.057	0.569	0.068	0.448	0.927	0.869	0.773	0.486	0.430
External count	Pearson's r	-0.018	0.102	-0.150	0.309	-0.309	0.166	-0.032	0.078	0.134	0.199	-0.289
	p-value	0.947	0.706	0.579	0.244	0.244	0.525	0.907	0.766	0.608	0.445	0.260
	Spearman's rho	0.000	-0.334	-0.342	0.226	-0.514 *	-0.088	-0.190	0.009	0.288	0.255	-0.267
	p-value	1.000	0.206	0.195	0.400	0.042	0.736	0.482	0.974	0.262	0.323	0.300
	Kendall's Tau B	0.000	-0.228	-0.289	0.188	-0.401 *	-0.055	-0.107	-0.022	0.209	0.194	-0.183
	p-value	1.000	0.253	0.169	0.378	0.049	0.768	0.582	0.901	0.247	0.316	0.318

Variable		Attention- ACE III	Memory- ACE III	Language- ACE III	Visuospatial ACE-III	Fluency- ACE III	ACE III Score	Digit Backwards	Trail A Time	Trail B Time	Word Recognition Accuracy	Source Accuracy
External ratio	Pearson's r	-0.109	-0.161	-0.394	0.063	-0.368	-0.122	-0.027	0.077	0.175	0.224	-0.338
	p-value	0.687	0.552	0.131	0.817	0.161	0.641	0.922	0.770	0.502	0.386	0.185
	Spearman's rho	-0.116	-0.219	-0.448	-0.122	-0.435	-0.221	0.027	0.058	0.194	0.194	-0.290
	p-value	0.670	0.414	0.082	0.652	0.092	0.393	0.921	0.826	0.456	0.455	0.259
	Kendall's Tau B	-0.096	-0.161	-0.332	-0.077	-0.292	-0.142	0.035	0.044	0.126	0.168	-0.221
	p-value	0.646	0.419	0.113	0.717	0.150	0.448	0.854	0.804	0.483	0.384	0.228

*statistically significant at $p = 0.05$

Table 3. Correlation matrix between neuropsychological tests and count and ratios scores on the AI (internal details and external events) for non-carriers only.

Variable		Attention- ACE III	Memory- ACE III	Fluency- ACE III	Language- ACE III	Visuospatial ACE-III	ACE III Score	Digit Backwards	Trail A Time	Trail B Time	Word Recognition Accuracy	Source Accuracy
Internal Count	Pearson's r	0.304	0.008	0.137	-0.007	0.286	0.237	-0.050	-0.025	-0.058	0.117	-0.043
	p-value	0.081	0.963	0.441	0.969	0.101	0.170	0.779	0.885	0.742	0.503	0.807
	Spearman's rho	0.396 *	0.055	0.061	-0.115	0.330	0.264	-0.002	-0.011	0.135	0.179	-0.042
	p-value	0.021	0.759	0.731	0.519	0.056	0.125	0.989	0.949	0.439	0.303	0.811
	Kendall's Tau B	0.309 *	0.062	0.044	-0.081	0.274	0.187	0.004	-0.002	0.096	0.132	-0.039
	p-value	0.027	0.636	0.747	0.553	0.050	0.132	0.976	0.989	0.425	0.305	0.752
Internal Ratio	Pearson's r	-0.009	-0.021	0.119	0.342 *	-0.204	-0.021	-0.089	0.038	0.218	-0.352 *	0.219
	p-value	0.961	0.908	0.501	0.048	0.246	0.907	0.618	0.827	0.208	0.038	0.207
	Spearman's rho	-0.077	-0.058	0.181	0.364 *	-0.211	-0.019	-0.126	-0.029	0.068	-0.358 *	0.222
	p-value	0.665	0.745	0.306	0.034	0.231	0.915	0.478	0.867	0.697	0.035	0.201
	Kendall's Tau B	-0.058	-0.044	0.135	0.277 *	-0.185	-0.039	-0.081	-0.015	0.041	-0.258 *	0.148
	p-value	0.677	0.737	0.318	0.042	0.186	0.752	0.525	0.898	0.733	0.045	0.229
External count	Pearson's r	0.111	0.167	0.020	-0.160	0.291	0.250	0.075	0.054	-0.114	0.314	-0.226
	p-value	0.533	0.345	0.911	0.365	0.095	0.148	0.675	0.759	0.516	0.066	0.191
	Spearman's rho	0.148	0.018	-0.001	-0.280	0.309	0.121	0.072	0.066	0.076	0.428 *	-0.210
	p-value	0.403	0.918	0.993	0.109	0.075	0.487	0.686	0.707	0.665	0.010	0.225
	Kendall's Tau B	0.116	0.034	-0.002	-0.216	0.253	0.098	0.054	0.034	0.053	0.331 **	-0.136
	p-value	0.405	0.795	0.987	0.113	0.071	0.430	0.672	0.776	0.659	0.010	0.270
External ratio	Pearson's r	-0.078	0.070	-0.064	-0.218	0.186	0.064	0.097	-0.010	-0.152	0.322	-0.267
	p-value	0.661	0.693	0.718	0.216	0.293	0.717	0.584	0.954	0.383	0.059	0.122

Variable		Attention- ACE III	Memory- ACE III	Fluency- ACE III	Language- ACE III	Visuospatial ACE-III	ACE III Score	Digit Backwards	Trail A Time	Trail B Time	Word Recognition Accuracy	Source Accuracy
	Spearman's rho	-0.012	0.102	-0.126	-0.191	0.159	0.043	0.132	0.025	-0.022	0.309	-0.291
	p-value	0.949	0.566	0.479	0.279	0.369	0.805	0.456	0.889	0.901	0.071	0.090
	Kendall's Tau B	-0.018	0.071	-0.096	-0.146	0.128	0.046	0.089	0.019	-0.020	0.209	-0.215
	p-value	0.899	0.582	0.478	0.283	0.361	0.709	0.486	0.876	0.864	0.104	0.080

*statistically significant at $p = 0.05$

Chapter Seven: Discussion and Critical Evaluation

Overview of results

In studies investigating declarative memory in people with AD or at the preclinical stage of the disease, semantic memory functioning has considerably received less attention when compared to episodic memory. The systematic review of the literature and the empirical study reported in the present thesis aimed to verify if the cognitive impact of increased genetic risk of developing AD (i.e., healthy people carrying the *APOE* ϵ 4 allele) would be limited to episodic memory or would also extend to personal and general forms of semantic memory.

The systematic review produced quite heterogenous findings on how semantic memory has been conceptualised and therefore assessed throughout the years. In particular, I reviewed 17 relevant papers and I observed that, apart from one single study that reported significant group differences (Staehelin et al., 1999), when semantic memory was tested via classic neuropsychological tests (i.e., verbal fluency, naming, language comprehension or general knowledge), the performance of *APOE* ϵ 4 carriers was not significantly different from non-carriers. When, instead, carriers were administered more complex semantic memory tasks, such as longer verbal fluency tasks (Rosen et al., 2020), retrieval fluency of autobiographical memory (Grilli et al., 2021), or the assessment of semantic clustering (Ford et al., 2020), these participants showed lower semantic memory performance as compared to non-carriers. The systematic review of the literature therefore suggested that, among those healthy people with increased genetic risk for AD, differences in semantic memory functioning may only emerge in more demanding tasks.

In this thesis, I also argued that autobiographical memory assessed via interview protocols could provide a more precise and ecologically valid assessment of episodic and semantic

memory in people at increased genetic of developing AD. Furthermore, the assessment of autobiographical memory in this population would also help to understand whether the impact of *APOE* $\epsilon 4$ is restricted to episodic memory only, or it also expands to personal and general forms of semantic memory. These forms of declarative memory have been recently investigated in the field of memory research (Renoult et al., 2012, 2020; see also Strikwerda-Brown et al., 2019), and also further fractioned in more specific sub-categories (Melega et al., 2024; Renoult et al., 2012, 2016; Tanguay et al., 2018).

In the empirical chapter of this thesis, I administered a novel interview protocol of autobiographical memory, the SAI (Melega et al., 2024), along with the original AI (Levine et al., 2002) a battery of neuropsychological tests on 19 healthy older *APOE* $\epsilon 4$ and 19 non-carriers, matched for age, gender, and years of education. This specific protocol allowed me to compare personal and general semantic forms of declarative memory, along with episodic memory.

The findings reported in this thesis revealed that *APOE* $\epsilon 4$ carriers showed reduced performance only on a test of recognition memory. On the AI, carriers also reportedly produced a smaller number of internal details and external events, meaning that their autobiographical recollection of episodic details was reduced as compared to non-carriers. In contrast, on the SAI, carriers and non-carriers did not significantly differ in terms of personal and general semantic production. In interpreting these results, I concluded that healthy older *APOE* $\epsilon 4$ carriers present with a selective reduction in episodic specificity when producing both internal (on-task) and external (off-task) episodic events in their autobiographical narratives. Nonetheless, both carriers and non-carriers showed a very similar on-task and off-task semantic production of personal and general semantic details.

In line with Melega et al. (2024), I also analysed the empirical data by adopting a different approach that included proportional scores. This approach divided the number of details

produced in every category listed in each interview by the total number of details produced by each participant. Count and proportional scores are not directly interchangeable (Locrow et al., 2024), but they provide a complimentary view of the data. Crucially, proportional scores provide an estimate as to whether carriers and non-carriers were on-task in each interview. Interestingly, when considering proportional scores, carriers and non-carriers did not significantly differ in the production of target details in each interview (see Chapter Six). This finding generally indicates that both groups were equally on task when producing target details in each interview.

Links to previous research

The findings from my systematic review underlined how the impact of *APOE* $\epsilon 4$ genotype on semantic memory remains limited, but also how some classic neuropsychological tasks that have so far been used to assess semantic memory also assess other cognitive domains such as executive functioning, attention, and language production abilities. Some authors indeed highlighted a certain theoretical ambiguity in how to classify tests of semantic memory (see Nilsson et al., 2006). As such, what mainly emerged from my systematic review of the literature is the need for more demanding and sensitive tasks designed to measure semantic memory functioning, especially in people with cognitive or genetic markers of preclinical AD (i.e., *APOE* $\epsilon 4$). Research advances in the field of memory indeed revisited the role of semantic memory in MCI and AD, which is suggested to be impaired in these populations, as already observed with episodic memory.

The findings from the empirical chapter of this thesis primarily reiterated that episodic memory is impaired in people at increased genetic risk of developing AD (Small et al., 2004;

Wisdom et al., 2011; O'Donoghue et al., 2018), as seen with the carriers' performance on the word recognition accuracy index, but also replicated previous research findings that assessed autobiographical memory in this population (see Grilli et al., 2018; Acevedo-Molina et al., 2023). Therefore, my empirical findings suggested a robust reduction in the specificity of episodic memory in *APOE* $\epsilon 4$ carriers. Such lack of specificity in episodic narrative abilities could therefore represent a nuanced type of cognitive decline in cognitively healthy older people at genetic risk for AD (see also Grilli et al., 2018).

When looking at personal and general semantic memory in autobiographical recall, carriers and non-carriers showed similar rates of semantic production. This largely suggests that both personal and general semantics are relatively spared and intact in *APOE* $\epsilon 4$ carriers, at least when tested with the tasks adopted here. These findings are also consistent with the notion that healthy older adults retain the gist of their personal experience (see Grilli & Sheldon, 2022), and this is reflected in a process of semanticization of autobiographical memories and narratives (Spreng et al., 2018; Lifanov et al., 2021), which was found to be more robust and generally less sensitive to increased genetic risk for AD. Instead, the specificity of episodic memory generally appears more vulnerable to increased genetic AD risk and could represent a subtle marker of incipient cognitive decline in *APOE* $\epsilon 4$ carriers.

Strengths and limitations of the thesis

This thesis extensively reviewed the available research literature by considering an aspect of declarative memory (i.e., semantic memory) that has not received the same consideration as episodic memory. Moreover, the type of population target for the review (i.e., healthy and cognitively unimpaired *APOE* $\epsilon 4$ carriers) was chosen to inform and expand the current evidence about declarative memory functioning in people who would otherwise be regarded as

cognitively healthy. Our review also allowed for a fine-grained analysis of the research evidence accrued so far, by considering the type of semantic memory task adopted to assess this memory function.

Although my findings are primarily consistent with past research evidence, they also raise quite heterogeneous views as to how semantic memory is understood and tested. Such heterogeneity was reflected, for instance, by different age groups of the participants involved in the selected papers, with a general bias towards including healthy older adults as compared to other groups, such as middle-aged adults or younger adults. The studies included in the review also did not consistently allocate participants to groups in terms of *APOE* genotypes, as some studies just divided participants by carriers and non-carriers while others stratified participants by specific genotype groups. Furthermore, in some specific tasks used to assess semantic memory, such as naming tasks, there was also the presence of ceiling effects, which raised the question as to whether this type of task would be appropriate to assess healthy older adults. Some studies included in the review also showed a tendency to include biased samples of highly educated participants that would not be representative of the general population. In general, what emerged in my systematic review is that neuropsychological tasks are only proxies for semantic memory and may capture other related neuropsychological traits. There are therefore limitations in the extent to which we can directly measure semantic memory due to it sitting underneath other systems (e.g. language production/word-finding, executive functioning).

The empirical chapter of this thesis reported data from a novel and original research design to assess personal and general semantic forms of declarative memory, along with episodic memory. Moreover, our design and research methodology allowed us to stratify our participants based on their genetic risk of developing late-onset AD and tested to assess whether there were any differences in their autobiographical recall when prompted to recall

personal events (i.e., episodic memory), life chapters (i.e., personal semantic), and culturally shared knowledge of events happening in the world (i.e., general semantic). Crucially, due to ethical concerns around disclosing sensitive information, the genetic status was not disclosed to the participants by the researcher. This allowed me to avoid any biases with the administration of the interview protocol and the scoring of the narratives, as I was not able to access information about participants' genetic status until data analysis. Moreover, as previously stated, the empirical study here reported was the first one to compare episodic, personal semantic, and general semantic autobiographical recall within the same experimental paradigm, and therefore the extent to which experimental hypotheses could be formulated was partly limited.

There were, nonetheless, some caveats that limited the generalizability and the interpretability of my empirical findings. Firstly, the probed life chapters were not equally balanced across the AI, PSAI, and GSAI, as participants in the GSAI were asked to recall culturally shared events or knowledge from last year only, while on the AI and PSAI participants were asked to recall specific life and personal life chapters from last year and also from 10 years ago. This constrained the comparison between the three interview protocols, as target count details on the GSAI were markedly lower than those on the AI and the PSAI. However, the use of proportional scores allowed a balanced comparison of target details across the three interview protocols, which resulted in no significant difference between groups.

Another methodological caveat of our paradigm derives from the order of the administration of the three interviews, whereby the GSAI was always administered at the end of the testing session when participants already sustained over an hour of interviewing in front of a screen. This could have, perhaps, also influenced the aforementioned lower scores in the GSAI, due to possible fatigue.

Throughout the interviews, participants from both groups were prompted to recall specific life events if they felt comfortable disclosing and discussing them in detail during the testing session. Given the age group of the participants tested in this thesis, some of them selected a life chapter where they lived through difficult personal circumstances, including distressing life events such as bereavement, health-related issues of oneself or a loved one, as compared to more pleasant life events (e.g., attending a wedding) or leisure activities (e.g., a holiday). Despite participants being frequently reminded to only discuss events they felt comfortable discussing, the examiner could not prevent what the participants eventually chose to discuss, and this inevitably created a quite heterogeneous content of autobiographical topics and narratives to be scored and then eventually analysed. Such individual differences could not be systematically controlled by my role as the experimenter as they would have altered the ecological validity of the interview protocol. Previous research indeed widely documented how the emotional content of recalled events can affect autobiographical recall (Bernsten & Rubin, 2002; St Jacques & Levine, 2007; Wardell et al., 2021), especially in the context of traumatic experiences (Blumenthal et al., 2024; Rubin et al., 2008). Nevertheless, it is unlikely that the effect of emotions could have impacted the ecological validity of the interview protocol administered to my participants.

Lastly, the interpretation of my empirical findings was also hampered by the subjectivity of the scoring procedure of autobiographical events. Although this was mitigated by high inter-rater reliability between my scoring and the scoring of a collaborator who acted as an independent rater, recent studies have started to adopt automated scoring via natural language processing powered by Artificial Intelligence (see van Genugten & Schacter, 2023; Klus et al., 2024). The usage of automated scoring processes allows for a less subjective and time-consuming method for data processing and scoring, although the current models are still at a preliminary stage in their development and a complete full scoring of autobiographical

narratives still depends on the number and types of memory detail types. On the other hand, automated scoring models are still not usable in studies using the present research paradigm as they have not been trained on subtypes of semantic details (Renoult et al., 2020), nor on the semantic autobiographical interview (Melega et al., 2024).

Theoretical Implications

The findings reported in this thesis have relevant theoretical implications that are not merely limited to people at increased genetic risk of developing late-onset AD, but they also expand our wider understanding of human declarative memory, especially in the domain of semantic memory.

The systematic review highlighted how, over the past 30 years of empirical research, the understanding and the assessment of semantic memory has predominantly relied on classic neuropsychological tests which largely overlap with other cognitive domains (e.g., executive functions, language abilities). This could explain why group differences in people at genetic risk of developing AD are usually not observed on these tasks, as perhaps observing such group differences would require more sensitive semantic memory tasks that would better match episodic memory. Furthermore, recent research has started to adopt more sensitive and ecologically valid autobiographical tests of personally relevant life chapters (Grilli et al., 2018, 2021) or general semantic knowledge (Renoult et al., 2020; Melega et al., 2024). These forms of declarative memory indeed rely on the recollection and the elaboration of one's personal past (i.e., personal semantic) as well as factual and culturally shared knowledge (i.e., general semantic).

Taken all together, the findings reported in this thesis directly support the idea of a novel understanding of declarative memory which moves away from the traditional episodic-

semantic memory distinction (see Tulving, 1972), which is currently being revisited (see Renoult et al., 2019). New theoretical advances have supported the consideration of a third system of declarative memory, personal semantics, which shares similarities with both episodic and semantic memory (see Renoult et al., 2012). Despite being commonly considered a form of semantic memory, personal semantics is still not well integrated into the current models of semantic memory and, more generally, into declarative memory. My empirical findings have here expanded our current understanding of personal and general semantic memory functioning in people with a genetic marker for late-onset sporadic AD, and how the novel task employed (SAI; Melega et al., 2024) is effectively sensitive to these two memory systems, as seen by the significant main effect of detail type in each interview, where target details were most frequently recalled. Indeed, these constructs were further tested and validated in a sub-clinical population that presents with a higher epidemiological likelihood of being at the preclinical stage of AD.

More specifically, I also found that autobiographical memory recollection could be dissociated as the gist of personal experience (i.e., personal semantic) and more specific details of lived events (i.e., episodic memory). As already highlighted by previous theoretical frameworks like the Fuzzy Trace Theory (see Reyna & Brainerd, 1995; Brainerd & Reyna, 2015), or the more recent Trace Transformation Theory (Moscovitch & Gilboa, 2021), healthy older people can retain the gist of personally lived experiences, and this is generally forgotten at a slower rate than memory for details, which highlights of process of *semanticization* (or *gistification*) of autobiographical narratives. This theoretical assumption has here also been further verified when declarative forms of autobiographical forms of declarative memory were assessed in people with an increased genetic for late-onset AD.

Clinical Implications

The findings reported in this thesis also have direct implications for clinical practice. As previously mentioned, we here recruited a group of otherwise cognitively healthy older adults and tested their ability to recall specific autobiographical events (episodic memory), personally relevant events (personal semantic), and their culturally shared knowledge of past events (general semantic) considering their genetic predisposition of developing late-onset AD.

APOE $\epsilon 4$ carriers present with a selective reduction in the specificity of episodic memory for both internal details and external events related to specific lived events that were prompted during the AI. This finding is also corroborated by their reduced performance in a neuropsychological task assessing word recognition memory. Clinically, this implies that people at increased genetic risk of developing AD show a subtle marker of cognitive decline reflected by differences in narrative abilities and the production of less specific episodic events. Nonetheless, as far as it concerns the autobiographical recollection of personal and general semantics, no differences were observed between carriers and non-carriers. As such, these semantic forms of declarative memory are expected to be relatively spared in healthy older *APOE* $\epsilon 4$ carriers. Instead, a reduction of episodic memory specificity in autobiographical remembering is well-documented in this population, and clinicians should therefore take this into account when assessing a person with such genetic predisposition, even in the absence of subjective memory complaints. It is, however, important to state that these changes in behavioural performance remain non-pathological and likely would not indicate clinical impairment at this stage, which is largely consistent with testing populations of healthy older participants. For instance, in the SAI, all participants were on-task and produced mostly on-task details, and performance at the recognition test was still high in carriers. Nevertheless, if we assume that some of these changes may be progressive and related to the risk of developing AD, they could then become meaningful clinically later on.

More broadly, my empirical findings also underline the translation impact that experimental cognitive research has in the field of clinical neuropsychology. In particular, the field of memory research can provide interesting clinical insights concerning incipient cognitive decline in people who also have a higher likelihood of developing late-onset AD. Experimental research can therefore contribute to the development of more sensitive clinical tests that would capture incipient cognitive decline in preclinical AD, which commonly evades the neuropsychological tests that are routinely being used in clinical settings (e.g., screening tools or comprehensive test batteries). In this endeavour, research in clinical neuropsychology would need to keep up with the current advances in genetic epidemiology and pharmacological interventions to better diagnose and treat cognitive decline in neurodegenerative diseases. This could allow clinicians to have not only a genetic marker and a drug treatment to slow down cognitive decline in AD but primarily a cognitive test that would sensitively aid the diagnostic process years or even decades before deterioration becomes clinically irreversible.

Future work ideas

The findings reported in this thesis, however, are not exhaustive but they just represent a starting point for further research ideas. Indeed, the empirical findings gathered from healthy older *APOE* $\epsilon 4$ carriers could be complemented by comparing them to a group of younger participants who are also *APOE* $\epsilon 4$ carriers, along with age-matched group of non-carriers. Such age-group comparison would clarify whether the episodic specificity deficit observed in healthy older carriers is also present in younger carriers or whether this reduced autobiographical narrative abilities are restricted to older *APOE* $\epsilon 4$ carriers. Similarly, comparing younger and older participants would also assess whether there are any age-related differences in the recollection of personal and general semantic events linked to *APOE* status.

Melega et al. (2024) indeed observed how healthy older adults tend to consistently produce more autobiographical facts and self-knowledge across interviews than younger adults, with an overall bias towards personal semantic information. Whether or not older *APOE* ϵ 4 carriers would also show this trend compared to younger *APOE* ϵ 4 carriers is still yet to be investigated.

Further investigations could involve a cross-sectional comparison with clinical groups affected by AD or specific types of FTD, such as semantic dementia, in line with previous research (see Renoult et al., 2020). A cross-sectional comparison with clinical groups would be fundamental to understand to which extent personal and general semantic forms of declarative memory are affected in people affected by neurodegenerative diseases, and how they differ when compared to age-matched healthy older *APOE* ϵ 4 carriers. Age-group comparisons would also help to clarify whether episodic memory deficits already occur in younger adults or if they emerge over time.

In the field of experimental cognitive research, behavioural data like the ones reported in this thesis also represent a solid background for further follow-up investigations involving more applied research methodologies, such as neuroimaging techniques (e.g., functional Magnetic Resonance Imaging and Electroencephalography). As a natural follow-up, it would, indeed, be interesting to understand if there are any structural or functional brain differences between healthy older *APOE* ϵ 4 carriers and non-carriers, and how these changes relate to the here presented behavioural data in autobiographical memory recall. Such neuroimaging data in *APOE* ϵ 4 carriers have already been collected and are currently under investigation. As both groups of carriers and non-carriers are composed of otherwise cognitively healthy older adults with similar age and education, it could be argued that brain differences could be quite nuanced, and generally more likely to be observed via functional rather than structural analyses, yet this remains an open question to answer which falls outside the scope of my thesis.

Lastly, a prospective longitudinal study would be important to track the trajectories of people with *APOE* $\epsilon 4$ over time. This would allow to understand if cognitive deficits represent a progressive decline for all individuals or for a portion of people to identify who is then going to convert to MCI and also AD and who is not, as already documented in previous research (Bretsky et al., 2003; Caselli et al., 1999, 2004, 2007, 2009; Deary et al. 2004; Schiepers et al., 2012). A more precise identification of markers of individuals at risk of conversion to MCI and AD would clinically translate into more selective and person-centred preventative treatments.

Overall conclusion

The past research evidence has shown largely heterogenous views on how semantic memory is conceptualised and assessed in people at genetic risk of developing AD. Generally, *APOE* $\epsilon 4$ carriers do not tend to differ from non-carriers when tested semantic memory is assessed via classic neuropsychological tests, whereas group differences can be found with more complex measures of verbal fluency, or retrieval fluency of autobiographical memories. This highlights how the impact of *APOE* $\epsilon 4$ on semantic memory is limited and confined to more demanding tasks, that represent a closer match to episodic memory tasks.

More specifically, I observed that *APOE* $\epsilon 4$ carriers present with a nuanced impairment in episodic specificity, as reflected by subtle differences in narrative abilities. This finding is consistent with previous research and was corroborated by reduced performance in word recognition accuracy tasks among carriers. Nevertheless, the on-task and off-task production of personal and general semantic memory details did not differ among groups, which underlies how autobiographical narratives that undergo a process of semanticization (or gistification) become more robust and less sensitive to genetic predisposition to AD, as compared to episodic memories.

My findings might help to redefine the structures and systems of declarative memory, in line with recent theoretical advances in the field of memory research. I also discussed how these findings inform our current understanding of incipient cognitive decline in preclinical AD for developing more sensitive tests that would capture subtle cognitive markers of late-onset AD.

References

- Acevedo, S. F., Piper, B. J., Craytor, M. J., Benice, T. S., & Raber, J. (2010). Apolipoprotein E4 and sex affect neurobehavioral performance in primary school children. *Pediatric Research*, 67(3), 293-299. <https://doi.org/10.1203/PDR.0b013e3181cb8e68>
- Acevedo-Molina, M. C., Matijevic, S., & Grilli, M. D. (2020). Beyond episodic remembering: Elaborative retrieval of lifetime periods in young and older adults. *Memory*, 28(1), 83-93. <https://doi.org/10.1080/09658211.2019.1686152>
- Acevedo-Molina, M. C., Thayer, S. C., Horn, K., Nkulu, H., Ryan, L., Andrews-Hanna, J. R., & Grilli, M. D. (2023). Past and future episodic detail retrieval is reduced among clinically normal older adults at higher genetic risk for late-onset Alzheimer's disease. *Neuropsychology*, 37(2), 194 –203. <https://doi.org/10.1037/neu0000866>
- Addis, D. R., & Tippett, L. (2004). Memory of myself: Autobiographical memory and identity in Alzheimer's disease. *Memory*, 12(1), 56-74. <https://doi.org/10.1080/09658210244000423>
- Addis, D. R., Wong, A. T., & Schacter, D. L. (2008). Age-related changes in the episodic simulation of future events. *Psychological Science*, 19(1), 33–41. <https://doi:10.1111/j.1467-9280.2008.02043.x>
- Addis, D. R., Sacchetti, D. C., Ally, B. A., Budson, A. E., & Schacter, D. L. (2009). Episodic simulation of future events is impaired in mild Alzheimer's disease. *Neuropsychologia*, 47(12), 2660–2671. <https://doi:10.1016/j.neuropsychologia.2009.05.018>
- Aizpurua, A., & Koutstaal, W. (2015). A matter of focus: Detailed memory in the intentional autobiographical recall of older and younger adults. *Consciousness and Cognition*, 33, 145–155. <https://doi:10.1016/j.concog.2014.12.006>

Alzheimer's Association. (2019). 2019 Alzheimer's disease facts and figures. *Alzheimer's & Dementia*, 15(3), 321–387. <https://doi.org/10.1016/j.jalz.2019.01.010>

Amer, T., Anderson, J. A., Campbell, K. L., Hasher, L., & Grady, C. L. (2016). Age differences in the neural correlates of distraction regulation: A network interaction approach. *Neuroimage*, 139, 231-239. <https://doi.org/10.1016/j.neuroimage.2016.06.036>

Amer, T., Giovanello, K. S., Grady, C. L., & Hasher, L. (2018). Age differences in memory for meaningful and arbitrary associations: A memory retrieval account. *Psychology and Aging*, 33(1), 74 -81. <https://dx.doi.org/10.1037/pag0000220>

Amer, T., Giovanello, K. S., Nichol, D. R., Hasher, L., & Grady, C. L. (2019). Neural correlates of enhanced memory for meaningful associations with age. *Cerebral Cortex*, 29(11), 4568–4579. <https://doi.org/10.1093/cercor/bhy334>

Amer, T., Wynn, J. S., & Hasher, L. (2022). Cluttered memory representations shape cognition in old age. *Trends in Cognitive Sciences*, 26(3), 255–267. <https://doi.org/10.1016/j.tics.2021.12.002>

Bäckman, L., & Nilsson, L. G. (1996). Semantic memory functioning across the adult life span. *European Psychologist*, 1(1), 27-33. <https://doi.org/10.1027/1016-9040.1.1.27>

Barnabe, A., Whitehead, V., Pilon, R., Arsenault-Lapierre, G., & Chertkow, H. (2012). Autobiographical memory in mild cognitive impairment and Alzheimer's disease: A comparison between the Levine and Kopelman interview methodologies. *Hippocampus*, 22(9), 1809–1825. <https://doi.org/10.1002/hipo.22015>

Barnier, A. J., Priddis, A. C., Broekhuijse, J. M., Harris, C. B., Cox, R. E., Addis, D. R., Keil, P. G., & Congleton, A. R. (2014). Reaping what they sow: Benefits of remembering

together in intimate couples. *Journal of Applied Research in Memory and Cognition*, 3(4), 261–265. <https://doi.org/10.1016/j.jarmac.2014.06.003>

Barry, T. J., Gregory, J. D., Latorre, J. M., Ros, L., Nieto, M., & Ricarte, J. J. (2021). A multi-method comparison of autobiographical memory impairments amongst younger and older adults. *Aging & Mental Health*, 25(5), 856-863. <https://doi.org/10.1080/13607863.2020.1729338>

Bastin, C., Feyers, D., Jedidi, H., Bahri, M. A., Degueldre, C., Lemaire, C., Collette, F., & Salmon, E. (2013). Episodic autobiographical memory in amnesic mild cognitive impairment: What are the neural correlates? *Human Brain Mapping*, 34(8), 1811–1825. <https://doi.org/10.1002/hbm.22032>

Benjamin, M. J., Cifelli, A., Garrard, P., Caine, D., & Jones, F. W. (2015). The role of working memory and verbal fluency in autobiographical memory in early Alzheimer's disease and matched controls. *Neuropsychologia*, 78, 115-121. <https://doi.org/10.1016/j.neuropsychologia.2015.10.006>

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society: Series B (Methodological)*, 57(1), 289–300. <https://doi.org/10.1111/j.2517-6161.1995.tb02031.x>

Berntsen, D., & Rubin, D. C. (2002). Emotionally charged autobiographical memories across the life span: The recall of happy, sad, traumatic and involuntary memories. *Psychology and Aging*, 17(4), 636–652. <https://doi.org/10.1037/0882-7974.17.4.636>

Binder, J. R., & Desai, R. H. (2011). The neurobiology of semantic memory. *Trends in Cognitive Sciences*, 15(11), 527-536. <https://doi.org/10.1016/j.tics.2011.10.001>

Blacker, D., Haines, J. L., Rodes, L., Terwedow, H., Go, R. C. P., Harrell, L. E., ... & Tanzi, R. (1997). APOE-4 and age at onset of Alzheimer's disease: the NIMH genetics initiative. *Neurology*, 48(1), 139-147. <https://doi.org/10.1212/WNL.48.1.139>

Bloss, C. S., Delis, D. C., Salmon, D. P., & Bondi, M. W. (2010). APOE genotype is associated with left-handedness and visuospatial skills in children. *Neurobiology of Aging*, 31(5), 787-795. <https://doi.org/10.1016/j.neurobiolaging.2008.05.021>

Bluck, S., Alea, N., Baron-Lee, J. M., & Davis, D. K. (2016). Story asides as a useful construct in examining adults' story recall. *Psychology and Aging*, 31(1), 42–57. <https://doi.org/10.1037/a0039990>

Blumenthal, A., Caparos, S., & Blanchette, I. (2024). Understanding the structure of autobiographical memories: A study of trauma memories from the 1994 Rwandan genocide. *Memory & Cognition*, 52,, 1597–1608. <https://doi.org/10.3758/s13421-024-01565-0>

Borgaonkar, D., Schmidt, L., Martin, S. E., Kanzer, M., Edelsohn, L., Growdon, J., & Farrer, L. (1993). Linkage of late-onset Alzheimer's disease with apolipoprotein E type 4 on chromosome 19. *Lancet*, 342(8871), 625-625. [https://doi.org/10.1016/0140-6736\(93\)91458-x](https://doi.org/10.1016/0140-6736(93)91458-x)

Brainerd, C. J., & Reyna, V. F. (2015). Fuzzy-trace theory and lifespan cognitive development. *Developmental Review*, 38, 89-121. <https://doi.org/10.1016/j.dr.2015.07.006>

Bretsky, P., Guralnik, J. M., Launer, L., Albert, M., & Seeman, T. E. (2003). The role of APOE-ε4 in longitudinal cognitive decline: MacArthur Studies of Successful Aging. *Neurology*, 60(7), 1077-1081. <https://doi.org/10.1212/01.WNL.0000055875.26908.24>

Buckley, R. F., Saling, M. M., Irish, M., Ames, D., Rowe, C. C., Villemagne, V. L., ... & Ellis, K. A. (2014). Autobiographical narratives relate to Alzheimer's disease biomarkers in

older adults. *International Psychogeriatrics*, 26(10), 1737-1746.
<https://doi.org/10.1017/S1041610214001136>

Buysse, D. J., Reynolds, C. F., III, Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, 28(2), 193–213. [https://doi.org/10.1016/0165-1781\(89\)90047-4](https://doi.org/10.1016/0165-1781(89)90047-4)

Cao, X., Madore, K. P., Wang, D., & Schacter, D. L. (2018). Remembering the past and imagining the future: attachment effects on production of episodic details in close relationships. *Memory*, 26(8), 1140-1150. <https://doi.org/10.1080/09658211.2018.1434800>

Carrión-Baralt, J. R., Meléndez-Cabrero, J., Rodríguez-Ubinas, H., Schmeidler, J., Beeri, M. S., Angelo, G., ... & Silverman, J. M. (2009). Impact of APOE ε4 on the cognitive performance of a sample of non-demented Puerto Rican nonagenarians. *Journal of Alzheimer's Disease*, 18(3), 533-540. <https://doi.org/10.3233/JAD-2009-1160>

Caselli, R. J., Graff–Radford, N. R., Reiman, E. M., Weaver, A., Osborne, D., Lucas, J., ... & Thibodeau, S. N. (1999). Preclinical memory decline in cognitively normal apolipoprotein E–ε4 homozygotes. *Neurology*, 53(1), 201-201. <https://doi.org/10.1212/WNL.53.1.201>

Caselli, R. J., Reiman, E. M., Osborne, D., Hentz, J. G., Baxter, L. C., Hernandez, J. L., & Alexander, G. G. (2004). Longitudinal changes in cognition and behavior in asymptomatic carriers of the APOE ε4 allele. *Neurology*, 62(11), 1990-1995. <https://doi.org/10.1212/01.WNL.0000129533.26544.BF>

Caselli, R. J., Reiman, E. M., Locke, D. E., Hutton, M. L., Hentz, J. G., Hoffman-Snyder, C., ... & Osborne, D. (2007). Cognitive domain decline in healthy apolipoprotein E ε4 homozygotes before the diagnosis of mild cognitive impairment. *Archives of Neurology*, 64(9), 1306-1311. <https://doi.org/10.1001/archneur.64.9.1306>

Caselli, R. J., Dueck, A. C., Osborne, D., Sabbagh, M. N., Connor, D. J., Ahern, G. L., ... & Reiman, E. M. (2009). Longitudinal modeling of age-related memory decline and the APOE $\epsilon 4$ effect. *New England Journal of Medicine*, 361(3), 255-263. <https://10.1056/NEJMoa0809437>

Caselli, R. J., & Reiman, E. M. (2012). Characterizing the preclinical stages of Alzheimer's disease and the prospect of presymptomatic intervention. *Journal of Alzheimer's Disease*, 33(s1), S405-S416. <https://doi.org/10.3233/JAD-2012-129026>

Chasles, M. J., Tremblay, A., Escudier, F., Lajeunesse, A., Benoit, S., Langlois, R., ... & Rouleau, I. (2020). An examination of semantic impairment in amnesic MCI and AD: What can we learn from verbal fluency?. *Archives of Clinical Neuropsychology*, 35(1), 22-30. <https://doi.org/10.1093/arclin/acz018>

Chen, Y., Araghi, M., Bandosz, P., Shipley, M. J., Ahmadi-Abhari, S., Lobanov-Rostovsky, S., ... & Brunner, E. J. (2023). Impact of hypertension prevalence trend on mortality and burdens of dementia and disability in England and Wales to 2060: a simulation modelling study. *The Lancet Healthy Longevity*, 4(9), e470-e477. [https://10.1016/S2468-2667\(23\)00214-1](https://10.1016/S2468-2667(23)00214-1)

Coelho, S., Guerreiro, M., Chester, C., Silva, D., Maroco, J., Paglieri, F., & de Mendonça, A. (2019). Mental time travel in mild cognitive impairment. *Journal of Clinical and Experimental Neuropsychology*, 41(8), 845–855. <https://doi:10.1080/13803395.2019.1632269>

Conway, M. A., Cohen, G., & Stanhope, N. (1991). On the very long-term retention of knowledge acquired through formal education: Twelve years of cognitive psychology. *Journal of Experimental Psychology: General*, 120(4), 395-409. <https://doi.org/10.1037/0096-3445.120.4.395>

Corder, E. H., Saunders, A. M., Strittmatter, W. J., Schmechel, D. E., Gaskell, P. C., Small, G., Roses, J.L., Haines, M.A., & Pericak-Vance, M. A. (1993). Gene dose of apolipoprotein E type 4 allele and the risk of Alzheimer's disease in late onset families. *Science*, 261(5123), 921-923. <https://doi:10.1126/science.8346443>

Coughlan, G., Laczó, J., Hort, J., Minihane, A. M., & Hornberger, M. (2018). Spatial navigation deficits—overlooked cognitive marker for preclinical Alzheimer disease?. *Nature Reviews Neurology*, 14(8), 496-506. <https://doi.org/10.1038/s41582-018-0031-x>

Davidson, Y., Gibbons, L., Pritchard, A., Hardicre, J., Wren, J., Stopford, C., ... & Mann, D. M. (2006). Apolipoprotein E ϵ 4 allele frequency and age at onset of Alzheimer's disease. *Dementia and Geriatric Cognitive Disorders*, 23(1), 60-66. <https://doi.org/10.1159/000097038>

De Brigard, F., Rodriguez, D. C., & Montañés, P. (2017). Exploring the experience of episodic past, future, and counterfactual thinking in younger and older adults: A study of a Colombian sample. *Consciousness and Cognition*, 51, 258-267. <https://doi.org/10.1016/j.concog.2017.04.007>

De Frias, C. M., Annerbrink, K., Westberg, L., Eriksson, E., Adolfsson, R., & Nilsson, L.-G. (2005). Catechol O-Methyltransferase Val158 Met polymorphism is associated with cognitive performance in nondemented adults. *Journal of Cognitive Neuroscience*, 17, 1018–1025. <https://doi.org/10.1162/0898929054475136>

Deary, I. J., Whiteman, M. C., Pattie, A., Starr, J. M., Hayward, C., Wright, A. F., ... & Whalley, L. J. (2004). Apolipoprotein e gene variability and cognitive functions at age 79: a follow-up of the Scottish mental survey of 1932. *Psychology and aging*, 19(2), 367 -371. <https://doi.org/10.1037/0882-7974.19.2.367>

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan Executive Function System (D-KEFS)*. APA PsycTests. <https://doi.org/10.1037/t15082-000>

Devitt, A. L., Addis, D. R., & Schacter, D. L. (2017). Episodic and semantic content of memory and imagination: A multilevel analysis. *Memory & Cognition*, 45, 1078-1094. <https://doi.org/10.3758/s13421-017-0716-1>

Diamond, N. B., Abdi, H., & Levine, B. (2020). Different patterns of recollection for matched real-world and laboratory-based episodes in younger and older adults. *Cognition*, 202, 104309. <https://doi:10.1016/j.cognition.2020.104309>

Donix, M., Burggren, A. C., Suthana, N. A., Siddarth, P., Ekstrom, A. D., Krupa, A. K., ... & Bookheimer, S. Y. (2010). Longitudinal changes in medial temporal cortical thickness in normal subjects with the APOE-4 polymorphism. *Neuroimage*, 53(1), 37-43. <https://doi.org/10.1016/j.neuroimage.2010.06.009>

Dritschel, B. H., Williams, J. M. G., Baddeley, A. D., & Nimmo-Smith, I. (1992). Autobiographical fluency: A method for the study of personal memory. *Memory & Cognition*, 20, 133-140. <https://doi.org/10.3758/BF03197162>

Duchek, J. M., Balota, D. A., & Cortese, M. (2006). Prospective memory and apolipoprotein E in healthy aging and early stage Alzheimer's disease. *Neuropsychology*, 20(6), 633–644. <https://doi.org/10.1037/0894-4105.20.6.633>

Duff, M. C., Covington, N. V., Hilverman, C., & Cohen, N. J. (2020). Semantic memory and the hippocampus: Revisiting, reaffirming, and extending the reach of their critical relationship. *Frontiers in Human Neuroscience*, 13, 471. <https://doi.org/10.3389/fnhum.2019.00471>

Dureman, I. (1960). *SRB: I*. Psykologiförlaget.

Dureman, I., Kebbon, L., & Österberg, E. (1971). *A manual to the DS-battery*. Psykologiförlaget.

Duval, C., Desgranges, B., de La Sayette, V., Belliard, S., Eustache, F., & Piolino, P. (2012). What happens to personal identity when semantic knowledge degrades? A study of the self and autobiographical memory in semantic dementia. *Neuropsychologia*, 50(2), 254-265. <https://doi.org/10.1016/j.neuropsychologia.2011.11.019>

Eich, T. S., Tsapanou, A., & Stern, Y. (2019). When time's arrow doesn't bend: APOE- ϵ 4 influences episodic memory before old age. *Neuropsychologia*, 133, 107180. <https://doi.org/10.1016/j.neuropsychologia.2019.107180>

El Haj, M., Antoine, P., Amouyel, P., Lambert, J. C., Pasquier, F., & Kapogiannis, D. (2016). Apolipoprotein E (APOE) ϵ 4 and episodic memory decline in Alzheimer's disease: A review. *Ageing Research Reviews*, 27, 15-22. <https://doi.org/10.1016/j.arr.2016.02.002>

Ekstrom, R.B., French, J.E.W., Harman, H.H., Dermen, D. (1976). *Manual for the Kit of Factor-Referenced Cognitive Tests*. Educational Testing Service.

Emrani, S., Arain, H. A., DeMarshall, C., & Nuriel, T. (2020). APOE4 is associated with cognitive and pathological heterogeneity in patients with Alzheimer's disease: a systematic review. *Alzheimer's Research & Therapy*, 12(1), 141. <https://doi.org/10.1186/s13195-020-00712-4>

Ewers, M., Sperling, R. A., Klunk, W. E., Weiner, M. W., & Hampel, H. (2011). Neuroimaging markers for the prediction and early diagnosis of Alzheimer's disease dementia. *Trends in Neurosciences*, 34(8), 430-442. <https://doi.org/10.1016/j.tins.2011.05.005>

Fan, C., Simpson, S., Sokolowski, H. M., & Levine, B. (2024). Autobiographical memory. In M.K. Kahana & K.D. Wagner (Eds.), *The Oxford Handbook of Human Memory*,

Two Volume Pack: Foundations and Applications (1st ed., pp. 1140–1170). Oxford Academic.
<https://doi.org/10.1093/oxfordhb/9780190917982.013.39>

Farrer, L. A., Cupples, L. A., Haines, J. L., Hyman, B., Kukull, W. A., Mayeux, R., ... & Van Duijn, C. M. (1997). Effects of age, sex, and ethnicity on the association between apolipoprotein E genotype and Alzheimer disease: a meta-analysis. *JAMA*, 278(16), 1349-1356. <https://doi:10.1001/jama.1997.03550160069041>

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behavior research methods*, 41(4), 1149-1160. <https://doi.org/10.3758/BRM.41.4.1149>

Ford, J. H., Rubin, D. C., & Giovanello, K. S. (2014). Effects of task instruction on autobiographical memory specificity in young and older adults. *Memory*, 22(6), 722-736. <https://doi.org/10.1080/09658211.2013.820325>

Ford, J., Zheng, B., Hurtado, B., de Jager, C. A., Udeh-Momoh, C., Middleton, L., & Price, G. (2020). Strategy or symptom: Semantic clustering and risk of Alzheimer's disease-related impairment. *Journal of Clinical and Experimental Neuropsychology*, 42(8), 849-856. <https://doi.org/10.1080/13803395.2020.1819964>

Fortea, J., Pegueroles, J., Alcolea, D., Belbin, O., Dols-Icardo, O., Vaqué-Alcázar, L., Gispert, J.D., Suarez-Calvet, M., Johnson, S.C., Sperling, R., Bejanin, A., Lleó, A., & Montal, V. (2024). APOE4 homozygosity represents a distinct genetic form of Alzheimer's disease. *Nature medicine*, 30, 1284–1291. <https://doi.org/10.1038/s41591-024-02931-w>

Foster, J. K., Albrecht, M. A., Savage, G., Lautenschlager, N. T., Ellis, K. A., Maruff, P., ... & AIBL Research Group. (2013). Lack of reliable evidence for a distinctive $\epsilon 4$ - related cognitive phenotype that is independent from clinical diagnostic status: findings from the

Australian Imaging, Biomarkers and Lifestyle Study. *Brain*, 136(7), 2201-2216.
<https://doi.org/10.1093/brain/awt127>

Fouquet, M., Besson, F. L., Gonneaud, J., La Joie, R., & Chételat, G. (2014). Imaging brain effects of APOE4 in cognitively normal individuals across the lifespan. *Neuropsychology Review*, 24, 290-299. <https://doi.org/10.1007/s11065-014-9263-8>

Gabrieli, J. D., Cohen, N. J., & Corkin, S. (1988). The impaired learning of semantic knowledge following bilateral medial temporal-lobe resection. *Brain and Cognition*, 7(2), 157-177. [https://doi.org/10.1016/0278-2626\(88\)90027-9](https://doi.org/10.1016/0278-2626(88)90027-9)

Gaesser, B., Sacchetti, D. C., Addis, D. R., & Schacter, D. L. (2011). Characterizing age-related changes in remembering the past and imagining the future. *Psychology and Aging*, 26(1), 80–84. <https://doi.org/10.1037/a0021054>

Gallagher, M., & Koh, M. T. (2011). Episodic memory on the path to Alzheimer's disease. *Current opinion in neurobiology*, 21(6), 929-934.
<https://doi.org/10.1016/j.conb.2011.10.021>

Gamboz, N., De Vito, S., Brandimonte, M. A., Pappalardo, S., Galeone, F., Iavarone, A., & Della Sala, S. (2010). Episodic future thinking in amnesic mild cognitive impairment. *Neuropsychologia*, 48(7), 2091-2097. <https://doi.org/10.1016/j.neuropsychologia.2010.03.030>

Gamboz, N., De Vito, S., Brandimonte, M. A., Pappalardo, S., Galeone, F., Iavarone, A., & Della Sala, S. (2010). Episodic future thinking in amnesic mild cognitive impairment. *Neuropsychologia*, 48(7), 2091-2097. <https://doi.org/10.1016/j.neuropsychologia.2010.03.030>

Greene, N. R., & Naveh-Benjamin, M. (2020). A specificity principle of memory: Evidence from aging and associative memory. *Psychological Science*, 31(3), 316-331.
<https://doi.org/10.1177/0956797620901760>

Greene, N. R., & Naveh-Benjamin, M. (2022). Adult age differences in specific and gist associative episodic memory across short-and long-term retention intervals. *Psychology and Aging*, 37(6), 681-697. <https://doi.org/10.1037/pag0000701>

Greene, N. R., & Naveh-Benjamin, M. (2023). Forgetting of specific and gist visual associative episodic memory representations across time. *Psychonomic Bulletin & Review*, 30(4), 1484-1501. <https://doi.org/10.3758/s13423-023-02256-8>

Greene, N. R., & Naveh-Benjamin, M. (2024). The time course of encoding specific and gist episodic memory representations among young and older adults. *Journal of Experimental Psychology: General*, 153(6), 1671–1697. <https://doi.org/10.1037/xge0001589>

Greenberg, D. L., Keane, M. M., Ryan, L., & Verfaellie, M. (2009). Impaired category fluency in medial temporal lobe amnesia: The role of episodic memory. *Journal of Neuroscience*, 29(35), 10900-10908. <https://doi.org/10.1523/JNEUROSCI.1202-09.2009>

Greenberg, D. L., & Verfaellie, M. (2010). Interdependence of episodic and semantic memory: Evidence from neuropsychology. *Journal of the International Neuropsychological Society*, 16(5), 748-753. <https://doi.org/10.1017/S1355617710000676>

Greenwood, P. M., Sunderland, T., Putnam, K., Levy, J., & Parasuraman, R. (2005). Scaling of visuospatial attention undergoes differential longitudinal change as a function of APOE genotype prior to old age: results from the NIMH BIOCARD study. *Neuropsychology*, 19(6), 830–840. <https://doi.org/10.1037/0894-4105.19.6.830>

Grilli, M. D., & Verfaellie, M. (2014). Personal semantic memory: insights from neuropsychological research on amnesia. *Neuropsychologia*, 61, 56-64. <https://doi.org/10.1016/j.neuropsychologia.2014.06.012>

Grilli, M. D., Wank, A. A., Bercel, J. J., & Ryan, L. (2018). Evidence for reduced autobiographical memory episodic specificity in cognitively normal middle-aged and older individuals at increased risk for Alzheimer's disease dementia. *Journal of the International Neuropsychological Society*, 24(10), 1073-1083. <https://doi.org/10.1017/S1355617718000577>

Grilli, M. D., Wank, A. A., Huentelman, M. J., & Ryan, L. (2021). Autobiographical memory fluency reductions in cognitively unimpaired middle-aged and older adults at increased risk for Alzheimer's disease dementia. *Journal of the International Neuropsychological Society*, 27(9), 905-915. <https://doi.org/10.1017/S1355617720001319>

Grilli, M. D., & Sheldon, S. (2022). Autobiographical event memory and aging: Older adults get the gist. *Trends in Cognitive Sciences*, 26(12), 1079-1089. <https://10.1016/j.tics.2022.09.007>

Habib, M., Mak, E., Gabel, S., Su, L., Williams, G., Waldman, A., ... & O'Brien, J. T. (2017). Functional neuroimaging findings in healthy middle-aged adults at risk of Alzheimer's disease. *Ageing Research Reviews*, 36, 88-104. <https://doi.org/10.1016/j.arr.2017.03.004>

Han, S. D., & Bondi, M. W. (2008). Revision of the apolipoprotein E compensatory mechanism recruitment hypothesis. *Alzheimer's & Dementia*, 4(4), 251-254. <https://doi.org/10.1016/j.jalz.2008.02.006>

Harman, D. (2006). Alzheimer's disease pathogenesis: role of aging. *Annals of the New York Academy of Sciences*, 1067(1), 454-460. <https://doi.org/10.1196/annals.1354.065>

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. *Psychology of Learning and Motivation*, 22, 193-225. [https://doi.org/10.1016/S0079-7421\(08\)60041-9](https://doi.org/10.1016/S0079-7421(08)60041-9)

Helkala, E. L., Koivisto, K., Hänninen, T., Vanhanen, M., Kervinen, K., Kuusisto, J., ... & Riekkinen Sr, P. (1995). The association of apolipoprotein E polymorphism with memory: a population based study. *Neuroscience Letters*, 191(3), 141-144. [https://doi.org/10.1016/0304-3940\(95\)11575-H](https://doi.org/10.1016/0304-3940(95)11575-H)

Henry, J. D., Crawford, J. R., & Phillips, L. H. (2004). Verbal fluency performance in dementia of the Alzheimer's type: a meta-analysis. *Neuropsychologia*, 42(9), 1212-1222. <https://doi.org/10.1016/j.neuropsychologia.2004.02.001>

Hsieh, S., Schubert, S., Hoon, C., Mioshi, E., & Hodges, J. R. (2013). Validation of the Addenbrooke's Cognitive Examination III in frontotemporal dementia and Alzheimer's disease. *Dementia and geriatric cognitive disorders*, 36(3-4), 242-250. <https://doi.org/10.1159/000351671>

Hilverman, C., & Duff, M. C. (2021). Evidence of impaired naming in patients with hippocampal amnesia. *Hippocampus*, 31(6), 612-626. <https://doi.org/10.1002/hipo.23325>

Hoffman, P., & Morcom, A. M. (2018). Age-related changes in the neural networks supporting semantic cognition: A meta-analysis of 47 functional neuroimaging studies. *Neuroscience & Biobehavioral Reviews*, 84, 134-150. <https://doi.org/10.1016/j.neubiorev.2017.11.010>

Ihle, A., Bunce, D., & Kliegel, M. (2012). APOE ε4 and cognitive function in early life: a meta-analysis. *Neuropsychology*, 26(3), 267-277. <https://doi.org/10.1037/a0026769>

Irish, M. (2023). Autobiographical memory in dementia syndromes—An integrative review. *Wiley Interdisciplinary Reviews: Cognitive Science*, 14(3), e1630. <https://doi.org/10.1002/wcs.1630>

Irish, M., Lawlor, B. A., O'Mara, S. M., & Coen, R. F. (2010). Exploring the recollective experience during autobiographical memory retrieval in amnesic mild cognitive impairment. *Journal of the International Neuropsychological Society*, 16(3), 546-555. <https://doi.org/10.1017/S1355617710000172>

Irish, M., Lawlor, B. A., O'Mara, S. M., & Coen, R. F. (2011). Impaired capacity for auto-noetic reliving during autobiographical event recall in mild Alzheimer's disease. *Cortex*, 47(2), 236-249. <https://doi.org/10.1016/j.cortex.2010.01.002>

Irish, M., Addis, D. R., Hodges, J. R., & Piguet, O. (2012). Exploring the content and quality of episodic future simulations in semantic dementia. *Neuropsychologia*, 50(14), 3488-3495. <https://doi.org/10.1016/j.neuropsychologia.2012.09.012>

Irish, M., Landin-Romero, R., Mothakunnel, A., Ramanan, S., Hsieh, S., Hodges, J. R., & Piguet, O. (2018). Evolution of autobiographical memory impairments in Alzheimer's disease and frontotemporal dementia—A longitudinal neuroimaging study. *Neuropsychologia*, 110, 14-25. <https://doi.org/10.1016/j.neuropsychologia.2017.03.014>

Irish, M., & Grilli, M. D. (2024). Interactions between episodic and semantic memory. In J.T. Wixted (Ed.), *Learning and Memory: A Comprehensive Reference* (3rd Ed. pp 1-19). Elsevier. <https://doi.org/10.1016/B978-0-443-15754-7.00009-2>

Jackson, R. J., Hyman, B. T., & Serrano-Pozo, A. (2024). Multifaceted roles of APOE in Alzheimer disease. *Nature Reviews Neurology*, 20(8), 457-474. <https://doi.org/10.1038/s41582-024-00988-2>

James, L. E., Burke, D. M., Austin, A., & Hulme, E. (1998). Production and perception of “verbosity” in younger and older adults. *Psychology and Aging*, 13(3), 355–367. <https://doi.org/10.1037/0882-7974.13.3.355>

Joubert, S., Brambati, S. M., Ansado, J., Barbeau, E. J., Felician, O., Didic, M., ... & Kergoat, M. J. (2010). The cognitive and neural expression of semantic memory impairment in mild cognitive impairment and early Alzheimer's disease. *Neuropsychologia*, 48(4), 978-988. <https://doi.org/10.1016/j.neuropsychologia.2009.11.019>

Joubert, S., Gardy, L., Didic, M., Rouleau, I., & Barbeau, E. J. (2021). A meta-analysis of semantic memory in mild cognitive impairment. *Neuropsychology Review*, 31, 221-232. <https://doi.org/10.1007/s11065-020-09453-5>

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *Boston Naming Test (BNT)*. APA PsycTests. <https://doi.org/10.1037/t27208-000>

Kausler, D. H. (1982). *Experimental psychology and human aging*. Wiley.

Kausler, D. H. (1991). *Experimental psychology, cognition, and human aging*. Springer-Verlag

Keane, M. M., Bousquet, K., Wank, A., & Verfaellie, M. (2020). Relational processing in the semantic domain is impaired in medial temporal lobe amnesia. *Journal of Neuropsychology*, 14(3), 416-430. <https://doi.org/10.1111/jnp.12196>

Klooster, N. B., & Duff, M. C. (2015). Remote semantic memory is impoverished in hippocampal amnesia. *Neuropsychologia*, 79, 42-52. <https://doi.org/10.1016/j.neuropsychologia.2015.10.017>

Klus, J., Cohen, D. E., Garcia, A. N., Mehl, M. R., Andrews-Hanna, J. R., Grilli, M. D. (2024). *Modeling Memories, Predicting Prospections: Automated Scoring of Autobiographical Detail Narration using Large Language Models*. PsyArXiv. <https://doi.org/10.31234/osf.io/n7cvq>

Knoff, A. A., Bowles, B., Andrews-Hanna, J. R., & Grilli, M. D. (2024). Direct access to specific autobiographical memories is lower in healthy middle-aged to older adult Apolipoprotein E ϵ 4 carriers compared to non-carriers. *Journal of Neuropsychology*. <https://doi.org/10.1111/jnp.12380>

Koenig, P., Smith, E. E., Moore, P., Glosser, G., & Grossman, M. (2007). Categorization of novel animals by patients with Alzheimer's disease and corticobasal degeneration. *Neuropsychology*, 21(2), 193–206. <https://doi.org/10.1037/0894-4105.21.2.193>

Kopelman, M. D., Wilson, B. A., & Baddeley, A. D. (1989). The autobiographical memory interview: a new assessment of autobiographical and personal semantic memory in amnesic patients. *Journal of Clinical and Experimental Neuropsychology*, 11(5), 724-744. <https://doi.org/10.1080/01688638908400928>

Kroenke, K., Spitzer, R. L., & Williams, J.B.(2001).ThePHQ-9:Validityof a brief depression severity measure. *Journal of General Internal Medicine*, 16(9), 606–613. <https://doi.org/10.1046/j.1525-1497.2001.016009606.x>

Kucikova, L., Goerdten, J., Dounavi, M. E., Mak, E., Su, L., Waldman, A. D., ... & Ritchie, C. W. (2021). Resting-state brain connectivity in healthy young and middle-aged adults at risk of progressive Alzheimer's disease. *Neuroscience & Biobehavioral Reviews*, 129, 142-153. <https://doi.org/10.1016/j.neubiorev.2021.07.024>

Lambon Ralph, M. A, Jefferies, E., Patterson, K., & Rogers, T. T. (2017). The neural and computational bases of semantic cognition. *Nature Reviews Neuroscience*, 18(1), 42-55. <https://doi.org/10.1038/nrn.2016.150>

Laukka, E. J., Lövdén, M., Herlitz, A., Karlsson, S., Ferencz, B., Pantzar, A., ... & Bäckman, L. (2013). Genetic effects on old-age cognitive functioning: a population-based study. *Psychology and Aging*, 28(1), 262–274. <https://doi.org/10.1037/a0030829>

Laurell, A. A., Venkataraman, A. V., Schmidt, T., Montagnese, M., Mueller, C., Stewart, R., ... & Underwood, B. R. (2024). Estimating demand for potential disease-modifying therapies for Alzheimer's disease in the UK. *The British Journal of Psychiatry*, 224(6), 198-204. <https://doi:10.1192/bjp.2023.166>

Lenth, R. (2021). Emmeans: Estimated marginal means, aka least-squares means. <https://CRAN.R-project.org/package=emmeans>.

Levine, B. (2004). Autobiographical memory and the self in time: Brain lesion effects, functional neuroanatomy, and lifespan development. *Brain and Cognition*, 55(1), 54-68. [https://doi.org/10.1016/S0278-2626\(03\)00280-X](https://doi.org/10.1016/S0278-2626(03)00280-X)

Levine, B., Black, S. E., Cabeza, R., Sinden, M., McIntosh, A. R., Toth, J. P., ... & Stuss, D. T. (1998). Episodic memory and the self in a case of isolated retrograde amnesia. *Brain*, 121(10), 1951-1973. <https://doi.org/10.1093/brain/121.10.1951>

Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: dissociating episodic from semantic retrieval. *Psychology and Aging*, 17(4), 677–689. <https://doi.org/10.1037/0882-7974.17.4.677>

Lifanov, J., Linde-Domingo, J., & Wimber, M. (2021). Feature-specific reaction times reveal a semanticisation of memories over time and with repeated remembering. *Nature communications*, 12(1), 3177. <https://doi.org/10.1038/s41467-021-23288-5>

Lezak, M. D., Howieson, D.B., Bigler, E.D., & Tranel, D. (2012). *Neuropsychological Assessment (fifth edition)*. Oxford University Press.

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., ... & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-

analyses of studies that evaluate health care interventions: explanation and elaboration. *Annals of Internal Medicine*, 151(4), W-65.

Liu, C. C., Kanekiyo, T., Xu, H., & Bu, G. (2013). Apolipoprotein E and Alzheimer disease: risk, mechanisms and therapy. *Nature Reviews Neurology*, 9(2), 106-118. <https://doi.org/10.1038/nrneurol.2012.263>

Lockrow, A. W., Setton, R., Spreng, K. A., Sheldon, S., Turner, G. R., & Spreng, R. N. (2024). Taking stock of the past: A psychometric evaluation of the Autobiographical Interview. *Behavior Research Methods*, 56(2), 1002-1038. <https://doi.org/10.3758/s13428-023-02080-x>

Machulda, M. M., Jones, D. T., Vemuri, P., McDade, E., Avula, R., Przybelski, S., ... & Jack, C. R. (2011). Effect of APOE ϵ 4 status on intrinsic network connectivity in cognitively normal elderly subjects. *Archives of Neurology*, 68(9), 1131-1136. <https://doi.org/10.1001/archneurol.2011.108>

Madore, K. P., Gaesser, B., & Schacter, D. L. (2014). Constructive episodic simulation: dissociable effects of a specificity induction on remembering, imagining, and describing in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 40(3), 609–622. <https://10.1037/a0034885>

Malek-Ahmadi, M., Raj, A., & Small, B. J. (2011). Semantic clustering as a neuropsychological predictor for amnesic-MCI. *Aging, Neuropsychology, and Cognition*, 18(3), 280-292. <https://doi.org/10.1080/13825585.2010.540642>

Martinelli, P., Sperduti, M., & Piolino, P. (2013). Neural substrates of the self-memory system: New insights from a meta-analysis. *Human Brain Mapping*, 34(7), 1515-1529. <https://doi.org/10.1002/hbm.22008>

Martinez, D. (2024). Scoring story recall for individual differences research: Central details, peripheral details, and automated scoring. *Behavior Research Methods*, 56, 8362–8378. <https://doi.org/10.3758/s13428-024-02480-7>

McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B. T., Jack Jr, C. R., Kawas, C. H., ... & Phelps, C. H. (2011). The diagnosis of dementia due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia*, 7(3), 263-269. <https://doi.org/10.1016/j.jalz.2011.03.005>

McKinnon, M. C., Nica, E. I., Sengdy, P., Kovacevic, N., Moscovitch, M., Freedman, M., ... & Levine, B. (2008). Autobiographical memory and patterns of brain atrophy in fronto-temporal lobar degeneration. *Journal of Cognitive Neuroscience*, 20(10), 1839-1853. <https://doi.org/10.1162/jocn.2008.20126>

McKinnon, M. C., Palombo, D. J., Nazarov, A., Kumar, N., Khuu, W., & Levine, B. (2015). Threat of death and autobiographical memory: A study of passengers from Flight AT236. *Clinical Psychological Science*, 3(4), 487–502. <https://doi.org/10.1177/216770261454228>

McLaughlin, P. M., Wright, M. J., LaRocca, M., Nguyen, P. T., Teng, E., Apostolova, L. G., ... & Woo, E. (2014). The “Alzheimer's type” profile of semantic clustering in amnesic mild cognitive impairment. *Journal of the International Neuropsychological Society*, 20(4), 402-412. <https://doi.org/10.1017/S135561771400006X>

Melega, G., Lancelotte, F., Johnen, A.-K., Hornberger, M., Levine, B., & Renoult, L. (2024). Evoking episodic and semantic details with instructional manipulation during autobiographical recall. *Psychology and Aging*, 39(4), 378–390. <https://doi.org/10.1037/pag0000821>

Methley, A. M., Campbell, S., Chew-Graham, C., McNally, R., & Cheraghi-Sohi, S. (2014). PICO, PICOS and SPIDER: a comparison study of specificity and sensitivity in three search tools for qualitative systematic reviews. *BMC health services research*, 14(1), 1-10. <https://doi.org/10.1186/s12913-014-0579-0>

Meulenbroek, O., Rijpkema, M., Kessels, R. P., Rikkert, M. G. O., & Fernández, G. (2010). Autobiographical memory retrieval in patients with Alzheimer's disease. *Neuroimage*, 53(1), 331-340. <https://doi.org/10.1016/j.neuroimage.2010.05.082>

Mintun, M. A., Lo, A. C., Duggan Evans, C., Wessels, A. M., Ardayfio, P. A., Andersen, S. W., ... & Skovronsky, D. M. (2021). Donanemab in early Alzheimer's disease. *New England Journal of Medicine*, 384(18), 1691-1704. <https://doi.org/10.1056/NEJMoa2100708>

Mioshi, E., Dawson, K., Mitchell, J., Arnold, R., & Hodges, J. R. (2006). The Addenbrooke's Cognitive Examination Revised (ACE-R): a brief cognitive test battery for dementia screening. *International Journal of Geriatric Psychiatry: A journal of the psychiatry of late life and allied sciences*, 21(11), 1078-1085. <https://doi.org/10.1002/gps.1610>

Mishra, S., Blazey, T. M., Holtzman, D. M., Cruchaga, C., Su, Y., Morris, J. C., ... & Gordon, B. A. (2018). Longitudinal brain imaging in preclinical Alzheimer disease: impact of APOE ϵ 4 genotype. *Brain*, 141(6), 1828-1839. <https://doi.org/10.1093/brain/awy103>

Mondadori, C. R., de Quervain, D. J. F., Buchmann, A., Mustovic, H., Wollmer, M. A., Schmidt, C. F., ... & Henke, K. (2007). Better memory and neural efficiency in young apolipoprotein E ϵ 4 carriers. *Cerebral Cortex*, 17(8), 1934-1947. <https://doi.org/10.1093/cercor/bhl103>

Murphy, G. L., & Shapiro, A. M. (1994). Forgetting of verbatim information in discourse. *Memory & Cognition*, 22, 85-94. <https://doi.org/10.3758/BF03202764>

Murphy, K. J., Troyer, A. K., Levine, B., & Moscovitch, M. (2008). Episodic, but not semantic, autobiographical memory is reduced in amnesic mild cognitive impairment. *Neuropsychologia*, 46(13), 3116-3123. <https://doi.org/10.1016/j.neuropsychologia.2008.07.004>

Nasreddine, Z. S., Phillips, N. A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., ... & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society*, 53(4), 695-699. <https://doi.org/10.1111/j.1532-5415.2005.53221.x>

Nebes, R. D. (1989). Semantic memory in Alzheimer's disease. *Psychological Bulletin*, 106(3), 377–394. <https://doi.org/10.1037/0033-2909.106.3.377>

Nichols, E., Steinmetz, J. D., Vollset, S. E., Fukutaki, K., Chalek, J., Abd-Allah, F., ... & Liu, X. (2022). Estimation of the global prevalence of dementia in 2019 and forecasted prevalence in 2050: an analysis for the Global Burden of Disease Study 2019. *The Lancet Public Health*, 7(2), e105-e125. [https://10.1016/S2468-2667\(21\)00249-8](https://10.1016/S2468-2667(21)00249-8)

Nilsson, L. G., BÄCKman, L., Erngrund, K., Nyberg, L., Adolfsson, R., Bucht, G., ... & Winblad, B. (1997). The Betula prospective cohort study: Memory, health, and aging. *Aging, Neuropsychology, and Cognition*, 4(1), 1-32. <https://doi.org/10.1080/13825589708256633>

Nilsson, L. G., Adolfsson, R., Bäckman, L., Cruts, M., Nyberg, L., Small, B. J., & Van Broeckoven, C. (2006). The influence of APOE status on episodic and semantic memory: data from a population-based study. *Neuropsychology*, 20(6), 645-657. <https://doi.org/10.1037/0894-4105.20.6.645>

Nyberg, L., Sandblom, J., Jones, S., Neely, A. S., Petersson, K. M., Ingvar, M., & Bäckman, L. (2003). Neural correlates of training-related memory improvement in adulthood

and aging. *Proceedings of the National Academy of Sciences*, 100(23), 13728-13733.
<https://doi.org/10.1073/pnas.1735487100>

O'Donoghue, M. C., Murphy, S. E., Zamboni, G., Nobre, A. C., & Mackay, C. E. (2018). APOE genotype and cognition in healthy individuals at risk of Alzheimer's disease: A review. *Cortex*, 104, 103-123. <https://doi.org/10.1016/j.cortex.2018.03.025>

O'Kane, G., Kensinger, E. A., & Corkin, S. (2004). Evidence for semantic learning in profound amnesia: an investigation with patient HM. *Hippocampus*, 14(4), 417-425.

Parasuraman, R., Greenwood, P. M., & Sunderland, T. (2002). The apolipoprotein E gene, attention, and brain function. *Neuropsychology*, 16(2), 254-274.
<https://doi.org/10.1037/0894-4105.16.2.254>

Payton, A., Van Den Boogerd, E., Davidson, Y., Gibbons, L., Ollier, W., Rabbitt, P., ... & Pendleton, N. (2006). Influence and interactions of cathepsin D, HLA-DRB1 and APOE on cognitive abilities in an older non-demented population. *Genes, Brain and Behavior*, 5(S1), 23-31. <https://doi.org/10.1111/j.1601-183X.2006.00191.x>

Peters, S. L., Fan, C. L., & Sheldon, S. (2019). Episodic memory contributions to autobiographical memory and open-ended problem-solving specificity in younger and older adults. *Memory & Cognition*, 47, 1592-1605. <https://doi.org/10.3758/s13421-019-00953-1>

Piolino, P., Desgranges, B., Belliard, S., Matuszewski, V., Lalevée, C., De La Sayette, V., & Eustache, F. (2003). Autobiographical memory and auto-noetic consciousness: triple dissociation in neurodegenerative diseases. *Brain*, 126(10), 2203-2219.
<https://doi.org/10.1093/brain/awg222>

Piolino, P., Desgranges, B., Clarys, D., Guillery-Girard, B., Taconnat, L., Isingrini, M., & Eustache, F. (2006). Autobiographical memory, auto-noetic consciousness, and self-

perspective in aging. *Psychology and Aging*, 21(3), 510–525. <https://doi.org/10.1037/0882-7974.21.3.510>

Pollock, A., & Berge, E. (2018). How to do a systematic review. *International Journal of Stroke*, 13(2), 138-156. <https://doi.org/10.1177/1747493017743796>

Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., Britten, N., Roen, K., & Duffy, S. (2006). Guidance on the conduct of narrative synthesis in systematic reviews. *A Product from the ESRC Methods Programme Version, 1*, p. b92.

Porsteinsson, A. P., Isaacson, R. S., Knox, S., Sabbagh, M. N., & Rubino, I. (2021). Diagnosis of early Alzheimer's disease: clinical practice in 2021. *The Journal of Prevention of Alzheimer's Disease*, 8, 371-386. <https://doi.org/10.14283/jpad.2021.23>

Rasmussen, J., & Langerman, H. (2019). Alzheimer's disease—why we need early diagnosis. *Degenerative Neurological and Neuromuscular Disease*, 9, 123–130. <https://doi.org/10.2147/DNND.S228939>

Raven, J.C. (1965) *The Mill Hill Vocabulary Scale*. H.K. Lewis.

Reiman, E. M., Arboleda-Velasquez, J. F., Quiroz, Y. T., Huentelman, M. J., Beach, T. G., Caselli, R. J., ... & Jun, G. R. (2020). Exceptionally low likelihood of Alzheimer's dementia in APOE2 homozygotes from a 5,000-person neuropathological study. *Nature Communications*, 11(1), 667. <https://doi.org/10.1038/s41467-019-14279-8>

Reitan, R. M. (1958). Validity of the Trail Making Test as an indicator of organic brain damage. *Perceptual and Motor Skills*, 8(3), 271–276. <https://doi.org/10.2466/pms.1958.8.3.271>

Renoult, L., Davidson, P. S., Palombo, D. J., Moscovitch, M., & Levine, B. (2012). Personal semantics: at the crossroads of semantic and episodic memory. *Trends in Cognitive Sciences*, 16(11), 550-558. <https://doi.org/10.1016/j.tics.2012.09.003>

Renoult, L., Tanguay, A., Beaudry, M., Tavakoli, P., Rabipour, S., Campbell, K., ... & Davidson, P. S. (2016). Personal semantics: Is it distinct from episodic and semantic memory? An electrophysiological study of memory for autobiographical facts and repeated events in honor of Shlomo Bentin. *Neuropsychologia*, 83, 242-256. <https://doi.org/10.1016/j.neuropsychologia.2015.08.013>

Renoult, L., Irish, M., Moscovitch, M., & Rugg, M. D. (2019). From knowing to remembering: the semantic–episodic distinction. *Trends in Cognitive Sciences*, 23(12), 1041-1057. <https://10.1016/j.tics.2019.09.008>

Renoult, L., Armson, M. J., Diamond, N. B., Fan, C. L., Jeyakumar, N., Levesque, L., Olivia, L., McKinnon, M., Papadopoulos, A., Selarka, D., St Jacques, P.L., & Levine, B. (2020). Classification of general and personal semantic details in the Autobiographical Interview. *Neuropsychologia*, 144, 107501. <https://doi.org/10.1016/j.neuropsychologia.2020.107501>

Reyna, V. F., & Brainerd, C. J. (1995). Fuzzy-trace theory: An interim synthesis. *Learning and individual Differences*, 7(1), 1-75. [https://doi.org/10.1016/1041-6080\(95\)90031-4](https://doi.org/10.1016/1041-6080(95)90031-4)

Robin, J., & Moscovitch, M. (2017). Familiar real-world spatial cues provide memory benefits in older and younger adults. *Psychology and Aging*, 32(3), 210–219. <https://doi.org/10.1037/pag0000162>

Ros, L., Romero, D., Ricarte, J. J., Serrano, J. P., Nieto, M., & Latorre, J. M. (2018). Measurement of overgeneral autobiographical memory: Psychometric properties of the

autobiographical memory test in young and older populations. *PloS One*, 13(4), <https://doi.org/10.1371/journal.pone.0196073>

Ros, L., Latorre, J. M., & Serrano, J. P. (2009). Working memory capacity and overgeneral autobiographical memory in young and older adults. *Aging, Neuropsychology, and Cognition*, 17(1), 89-107. <https://doi.org/10.1080/13825580903042650>

Rosen, V. M., Sunderland, T., Levy, J., Harwell, A., McGee, L., Hammond, C., ... & Lefkowitz, C. (2005). Apolipoprotein E and category fluency: evidence for reduced semantic access in healthy normal controls at risk for developing Alzheimer's disease. *Neuropsychologia*, 43(4), 647-658. <https://doi.org/10.1016/j.neuropsychologia.2004.06.022>

Rosenbaum, R. S., Gilboa, A., Levine, B., Winocur, G., & Moscovitch, M. (2009). Amnesia as an impairment of detail generation and binding: evidence from personal, fictional, and semantic narratives in KC. *Neuropsychologia*, 47(11), 2181-2187. <https://doi.org/10.1016/j.neuropsychologia.2008.11.028>

Rubin, D. C., Boals, A., & Berntsen, D. (2008). Memory in posttraumatic stress disorder: properties of voluntary and involuntary, traumatic and nontraumatic autobiographical memories in people with and without posttraumatic stress disorder symptoms. *Journal of Experimental Psychology: General*, 137(4), 591–614. <https://doi.org/10.1037/a0013165>

Sachs, J. S. (1967). Recognition memory for syntactic and semantic aspects of connected discourse. *Perception & Psychophysics*, 2(9), 437-442. <https://doi.org/10.3758/BF03208784>

Sacripante, R., McIntosh, R. D., & Della Sala, S. (2019). Benefit of wakeful resting on gist and peripheral memory retrieval in healthy younger and older adults. *Neuroscience Letters*, 705, 27-32. <https://doi.org/10.1016/j.neulet.2019.04.026>

Sacripante, R., Girtler, N., Doglione, E., Nobili, F., & Della Sala, S. (2023a). Forgetting rates of prose memory in Mild Cognitive Impairment. *Journal of Alzheimer's Disease*, 91(4), 1385-1394. <https://doi.org/10.3233/JAD-220803>

Sacripante, R., Logie, R. H., Baddeley, A., & Della Sala, S. (2023b). Forgetting rates of gist and peripheral episodic details in prose recall. *Memory & Cognition*, 51(1), 71-86. <https://doi.org/10.3758/s13421-022-01310-5>

Sacripante, R., James, T., Hornberger, M., Blake, J., & Renoult, L. (2025). Semantic Memory in Healthy Apolipoprotein ε4 Carriers: A Systematic Review. *medRxiv*, 2025-03. <https://doi.org/10.1101/2025.03.07.25323557>

Salo, A., Ylikoski, R., Verkkoniemi, A., Polvikoski, T., Juva, K., Rastas, S., ... & Sulkava, R. (2001). Does apolipoprotein E influence learning and memory in the nondemented oldest old?. *International Psychogeriatrics*, 13(4), 451-459. <https://doi.org/10.1017/S1041610201007864>

Salo, A., Ylikoski, R., Verkkoniemi, A., Polvikoski, T., Juva, K., Rastas, S., ... & Sulkava, R. (2001). Does apolipoprotein E influence learning and memory in the nondemented oldest old?. *International Psychogeriatrics*, 13(4), 451-459. <https://doi.org/10.1017/S1041610201007864>

Salthouse, T. A. (1991). *Theoretical perspectives on cognitive aging*. Erlbaum.

Salthouse, T. A. (1993a). Speed and knowledge as determinants of adult age differences in verbal tasks. *Journal of Gerontology*, 48(1), 29-36. <https://doi.org/10.1093/geronj/48.1.P29>

Salthouse, T. A. (1993b). Speed mediation of adult age differences in cognition. *Developmental Psychology*, 29(4), 722–738. <https://doi.org/10.1037/0012-1649.29.4.722>

Salthouse, T. A., Atkinson, T. M., & Berish, D. E. (2003). Executive functioning as a potential mediator of age-related cognitive decline in normal adults. *Journal of Experimental Psychology: General*, 132(4), 566-594. <https://doi.org/10.1037/0096-3445.132.4.566>

Scheltens, P., De Strooper, B., Kivipelto, M., Holstege, H., Chételat, G., Teunissen, C. E., ... & van der Flier, W. M. (2021). Alzheimer's disease. *The Lancet*, 397(10284), 1577-1590. [https://10.1016/S0140-6736\(20\)32205-4](https://10.1016/S0140-6736(20)32205-4)

Schiepers, O. J. G., Harris, S. E., Gow, A. J., Pattie, A., Brett, C. E., Starr, J. M., & Deary, I. J. (2012). APOE E4 status predicts age-related cognitive decline in the ninth decade: longitudinal follow-up of the Lothian Birth Cohort 1921. *Molecular Psychiatry*, 17(3), 315-324. <https://doi.org/10.1038/mp.2010.137>

Sekeres, M. J., Bonasia, K., St-Laurent, M., Pishdadian, S., Winocur, G., Grady, C., & Moscovitch, M. (2016). Recovering and preventing loss of detailed memory: differential rates of forgetting for detail types in episodic memory. *Learning & Memory*, 23(2), 72-82. <http://www.learnmem.org/cgi/doi/10.1101/lm.039057.115>

Sheldon, S., & Moscovitch, M. (2012). The nature and time-course of medial temporal lobe contributions to semantic retrieval: An fMRI study on verbal fluency. *Hippocampus*, 22(6), 1451-1466. <https://doi.org/10.1002/hipo.20985>

Sheldon, S., & Levine, B. (2015). The medial temporal lobes distinguish between within-item and item-context relations during autobiographical memory retrieval. *Hippocampus*, 25(12), 1577-1590.

Sheldon, S., Sheldon, J., Zhang, S., Setton, R., Turner, G. R., Spreng, R. N., & Grilli, M. D. (2024). Differences in the content and coherence of autobiographical memories between younger and older adults: Insights from text analysis. *Psychology and Aging*, 39(1), 59 –71. <https://doi.org/10.1037/pag0000769>

Simpson, S., Eskandaripour, M., & Levine, B. (2023). Effects of healthy and neuropathological aging on autobiographical memory: A meta-analysis of studies using the Autobiographical Interview. *The Journals of Gerontology: Series B*, 78(10), 1617-1624.

<https://doi.org/10.1093/geronb/gbad077>

Small, B. J., Rosnick, C. B., Fratiglioni, L., & Bäckman, L. (2004). Apolipoprotein E and cognitive performance: a meta-analysis. *Psychology and Aging*, 19(4), 592-600.

<https://doi.org/10.1037/0882-7974.19.4.592>

Smith, G. E., Bohac, D. L., Waring, S. C., Kokmen, E., Tangalos, E. G., Ivnik, R. J., & Petersen, R. C. (1998). Apolipoprotein E genotype influences cognitive ‘phenotype’ in patients with Alzheimer's disease but not in healthy control subjects. *Neurology*, 50(2), 355-362.

<https://doi.org/10.1212/WNL.50.2.35>

Spitzer, R. L., Kroenke, K., Williams, J. B., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of internal medicine*, 166(10), 1092-1097. <https://doi:10.1001/archinte.166.10.1092>

Spreng, R. N., Lockrow, A. W., DuPre, E., Setton, R., Spreng, K. A., & Turner, G. R. (2018). Semanticized autobiographical memory and the default–executive coupling hypothesis of aging. *Neuropsychologia*, 110, 37-43.

<https://doi.org/10.1016/j.neuropsychologia.2017.06.009>

St. Jacques, P. L., & Levine, B. (2007). Ageing and autobiographical memory for emotional and neutral events. *Memory*, 15(2), 129-144.

<https://doi.org/10.1080/09658210601119762>

Staehelin, H. B., Perrig-Chiello, P., Mittrache, C., Miserez, A. R., & Perrig, W. J. (1999). Apolipoprotein E genotypes and cognitive functions in healthy elderly persons. *Acta*

Neurologica Scandinavica, 100(1), 53-60. <https://doi.org/10.1111/j.1600-0404.1999.tb00723.x>

Stern, R. A., & White, T. (2003). *NAB, neuropsychological assessment battery: Administration, scoring, and interpretation manual*. Psychological Assessment Resources.

Storandt, M. (2008). Cognitive deficits in the early stages of Alzheimer's disease. *Current Directions in Psychological Science*, 17(3), 198-202. <https://doi.org/10.1111/j.1467-8721.2008.00574.x>

Strikwerda-Brown, C., Mothakunnel, A., Hodges, J. R., Piguet, O., & Irish, M. (2019). External details revisited—A new taxonomy for coding ‘non-episodic’ content during autobiographical memory retrieval. *Journal of Neuropsychology*, 13(3), 371-397. <https://doi.org/10.1111/jnp.12160>

Suri, S., Heise, V., Trachtenberg, A. J., & Mackay, C. E. (2013). The forgotten APOE allele: a review of the evidence and suggested mechanisms for the protective effect of APOE ϵ 2. *Neuroscience & Biobehavioral Reviews*, 37(10), 2878-2886. <https://doi.org/10.1016/j.neubiorev.2013.10.010>

Taler, V., Voronchikhina, A., Gorfine, G., & Lukasik, M. (2016). Knowledge of semantic features in mild cognitive impairment. *Journal of Neurolinguistics*, 38, 56-70. <https://doi.org/10.1016/j.jneuroling.2015.11.002>

Taler, V., Monetta, L., Sheppard, C., & Ohman, A. (2020). Semantic function in mild cognitive impairment. *Frontiers in Psychology*, 10, 3041. <https://doi.org/10.3389/fpsyg.2019.03041>

Tanguay, A. N., Benton, L., Romio, L., Sievers, C., Davidson, P. S., & Renoult, L. (2018). The ERP correlates of self-knowledge: Are assessments of one's past, present, and

future traits closer to semantic or episodic memory?. *Neuropsychologia*, 110, 65-83.
<https://doi.org/10.1016/j.neuropsychologia.2017.10.024>

Tanguay, A., Thériault, K., Clough, S., Taler, V., Renoult, L., & Davidson, P. (2024). *The Properties of Personal Semantics*. PsyArXiv. <https://osf.io/preprints/psyarxiv/3d8m7>

Thorndyke, P. W. (1977). Cognitive structures in comprehension and memory of narrative discourse. *Cognitive Psychology*, 9(1), 77-110. [https://doi.org/10.1016/0010-0285\(77\)90005-6](https://doi.org/10.1016/0010-0285(77)90005-6)

Tramoni, E., Felician, O., Koric, L., Balzamo, M., Joubert, S., & Ceccaldi, M. (2012). Alteration of autobiographical memory in amnesic mild cognitive impairment. *Cortex*, 48(10), 1310-1319. <https://doi.org/10.1016/j.cortex.2011.09.002>

Trunk, D. L., & Abrams, L. (2009). Do younger and older adults' communicative goals influence off-topic speech in autobiographical narratives? *Psychology and Aging*, 24(2), 324–337. <https://doi.org/10.1037/a0015259>

Tse, C. S., Balota, D. A., Moynan, S. C., Duchek, J. M., & Jacoby, L. L. (2010). The utility of placing recollection in opposition to familiarity in early discrimination of healthy aging and very mild dementia of the Alzheimer's type. *Neuropsychology*, 24(1), 49 – 67. <https://doi.org/10.1037/a0014887>

Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology*, 53(1), 1–25. <https://doi.org/10.1146/annurev.psych.53.100901.135114>

van Genugten, R. D., & Schacter, D. L. (2024). Automated scoring of the autobiographical interview with natural language processing. *Behavior Research Methods*, 56(3), 2243-2259. <https://doi.org/10.3758/s13428-023-02145-x>

Verfaellie, M., Bousquet, K., & Keane, M. M. (2014). Medial temporal and neocortical contributions to remote memory for semantic narratives: evidence from amnesia. *Neuropsychologia*, 61, 105-112. <https://doi.org/10.1016/j.neuropsychologia.2014.06.018>

Verhaegen, C., & Poncelet, M. (2013). Changes in naming and semantic abilities with aging from 50 to 90 years. *Journal of the International Neuropsychological Society*, 19(2), 119-126. <https://doi.org/10.1017/S1355617712001178>

Verma, M., & Howard, R. J. (2012). Semantic memory and language dysfunction in early Alzheimer's disease: a review. *International Journal of Geriatric Psychiatry*, 27(12), 1209-1217. <https://doi.org/10.1002/gps.3766>

Wank, A. A., Andrews-Hanna, J. R., & Grilli, M. D. (2021). Searching for the past: Exploring the dynamics of direct and generative autobiographical memory reconstruction among young and cognitively normal older adults. *Memory & Cognition*, 49, 422-437. <https://doi.org/10.3758/s13421-020-01098-2>

Wardell, V., Esposito, C.L., Madan, C.R., & Palombo, D. J. (2021a). Semi-automated transcription and scoring of autobiographical memory narratives. *Behavior Research Methods*, 53(2), 507–517. <https://doi.org/10.3758/s13428-020-01437-w>

Wardell, V., Madan, C. R., Jameson, T. J., Cocquyt, C. M., Checknita, K., Liu, H., & Palombo, D. J. (2021b). How emotion influences the details recalled in autobiographical memory. *Applied Cognitive Psychology*, 35(6), 1454-1465. <https://doi.org/10.1002/acp.3877>

Warrington, E. K., & McCarthy, R. A. (1988). The fractionation of retrograde amnesia. *Brain and Cognition*, 7(2), 184-200. [https://doi.org/10.1016/0278-2626\(88\)90029-2](https://doi.org/10.1016/0278-2626(88)90029-2)

Wechsler, D. (1987). *Wechsler Memory Scale–Revised*. Psychological Corporation.

Wechsler, D. (2008). *WAIS-IV Manual*. Psychological Corporation.

Weissberger, G. H., Nation, D. A., Nguyen, C. P., Bondi, M. W., & Han, S. D. (2018). Meta-analysis of cognitive ability differences by apolipoprotein e genotype in young humans. *Neuroscience & Biobehavioral Reviews*, 94, 49-58. <https://doi.org/10.1016/j.neubiorev.2018.08.009>

Wikgren, M., Karlsson, T., Nilbrink, T., Nordfjäll, K., Hultdin, J., Slegers, K., ... & Norrback, K. F. (2012). APOE ε4 is associated with longer telomeres, and longer telomeres among ε4 carriers predicts worse episodic memory. *Neurobiology of Aging*, 33(2), 335-344. <https://doi.org/10.1016/j.neurobiolaging.2010.03.004>

Wilson, R. S., Bienias, J. L., Berry-Kravis, E., Evans, D. A., & Bennett, D. A. (2002). The apolipoprotein E ε2 allele and decline in episodic memory. *Journal of Neurology, Neurosurgery & Psychiatry*, 73(6), 672-677. <https://doi.org/10.1136/jnnp.73.6.672>

Wisdom, N. M., Callahan, J. L., & Hawkins, K. A. (2011). The effects of apolipoprotein E on non-impaired cognitive functioning: a meta-analysis. *Neurobiology of Aging*, 32(1), 63-74. <https://doi.org/10.1016/j.neurobiolaging.2009.02.003>

Woodcock, R.W., Johnson, M.B., & Mather, N. (1989). Woodcock-Johnson Psychoeducational-Revised. DLM Teaching Resources.

Xu, Q., Liang, Z., & Huang, Y. (2024). APOE4 homozygosity is a new genetic form of Alzheimer's disease. *Nature Medicine*, 30, 1241–1242 (2024). <https://doi.org/10.1038/s41591-024-02923-w>

Zavagnin, M., De Beni, R., Borella, E., & Carretti, B. (2016). Episodic future thinking: the role of working memory and inhibition on age-related differences. *Aging Clinical and Experimental Research*, 28, 109-119. <https://doi.org/10.1007/s40520-015-0368-6>

Zhang, Q., Sidorenko, J., Couvy-Duchesne, B., Marioni, R. E., Wright, M. J., Goate, A. M., ... & Visscher, P. M. (2020). Risk prediction of late-onset Alzheimer's disease implies an oligogenic architecture. *Nature communications*, 11(1), 4799.
<https://doi.org/10.1038/s41467-020-18534-1>

Appendix A: Neuroscience and Biobehavioural Reviews

Instructions for Authors

Taken from: <https://www.sciencedirect.com/journal/neuroscience-and-biobehavioral-reviews/publish/guide-for-authors>

Writing and formatting

File format

We ask you to provide editable source files for your entire submission (including figures, tables and text graphics). Some guidelines:

- Save files in an editable format, using the extension .doc/.docx for Word files and .tex for LaTeX files. A PDF is not an acceptable source file.
- Lay out text in a single-column format.
- Remove any strikethrough and underlined text from your manuscript, unless it has scientific significance related to your article.
- Use spell-check and grammar-check functions to avoid errors.

We advise you to read our [Step-by-step guide to publishing with Elsevier](#).

Title page

You are required to include the following details in the title page information:

- Article title. Article titles should be concise and informative. Please avoid abbreviations and formulae, where possible, unless they are established and widely understood, e.g., DNA).
- Author names. Provide the given name(s) and family name(s) of each author. The order of authors should match the order in the submission system. Carefully check that all names are accurately spelled. If needed, you can add your name between parentheses in your own script after the English transliteration.
- Affiliations. Add affiliation addresses, referring to where the work was carried out, below the author names. Indicate affiliations using a lower-case superscript letter immediately after the author's name and in front of the corresponding address. Ensure that you provide the full postal address of each affiliation, including the country name and, if available, the email address of each author.
- Corresponding author. Clearly indicate who will handle correspondence for your article at all stages of the refereeing and publication process and also post-publication. This responsibility includes answering any future queries about your results, data, methodology and materials. It is important that the email address and contact details of your corresponding author are kept up to date during the submission and publication process.
- Present/permanent address. If an author has moved since the work described in your article was carried out, or the author was visiting during that time, a "present address" (or "permanent address") can be indicated by a footnote to the author's name. The address where

the author carried out the work must be retained as their main affiliation address. Use superscript Arabic numerals for such footnotes.

Abstract

You are required to provide a concise and factual abstract which does not exceed 250 words. The abstract should briefly state the purpose of your research, principal results and major conclusions. Some guidelines:

- Abstracts must be able to stand alone as abstracts are often presented separately from the article.
- Avoid references. If any are essential to include, ensure that you cite the author(s) and year(s).
- Avoid non-standard or uncommon abbreviations. If any are essential to include, ensure they are defined within your abstract at first mention.

Keywords

You are required to provide 1 to 7 keywords for indexing purposes. Keywords should be written in English. Please try to avoid keywords consisting of multiple words (using "and" or "of").

We recommend that you only use abbreviations in keywords if they are firmly established in the field.

Highlights

You are required to provide article highlights at submission.

Highlights are a short collection of bullet points that should capture the novel results of your research as well as any new methods used during your study. Highlights will help increase the discoverability of your article via search engines. Some guidelines:

- Submit highlights as a separate editable file in the online submission system with the word "highlights" included in the file name.
- Highlights should consist of 3 to 5 bullet points, each a maximum of 85 characters, including spaces.

We encourage you to view example [article highlights](#) and read about the benefits of their inclusion.

Graphical abstract

You are encouraged to provide a graphical abstract at submission.

The graphical abstract should summarize the contents of your article in a concise, pictorial form which is designed to capture the attention of a wide readership. A graphical abstract will help draw more attention to your online article and support readers in digesting your research. Some guidelines:

- Submit your graphical abstract as a separate file in the online submission system.
- Ensure the image is a minimum of 531 x 1328 pixels (h x w) or proportionally more and is readable at a size of 5 x 13 cm using a regular screen resolution of 96 dpi.
- Our preferred file types for graphical abstracts are TIFF, EPS, PDF or MS Office files.

We encourage you to view example [graphical abstracts](#) and read about the benefits of including them.

Tables

Tables must be submitted as editable text, not as images. Some guidelines:

- Place tables next to the relevant text or on a separate page(s) at the end of your article.
- Cite all tables in the manuscript text.
- Number tables consecutively according to their appearance in the text.
- Please provide captions along with the tables.
- Place any table notes below the table body.
- Avoid vertical rules and shading within table cells.

We recommend that you use tables sparingly, ensuring that any data presented in tables is not duplicating results described elsewhere in the article.

Figures, images and artwork

Figures, images, artwork, diagrams and other graphical media must be supplied as separate files along with the manuscript. We recommend that you read our detailed [artwork and media instructions](#). Some excerpts:

When submitting artwork:

- Cite all images in the manuscript text.
- Number images according to the sequence they appear within your article.
- Submit each image as a separate file using a logical naming convention for your files (for example, Figure_1, Figure_2 etc).
- Please provide captions for all figures, images, and artwork.
- Text graphics may be embedded in the text at the appropriate position. If you are working with LaTeX, text graphics may also be embedded in the file.

Artwork formats

When your artwork is finalized, "save as" or convert your electronic artwork to the formats listed below taking into account the given resolution requirements for line drawings, halftones, and line/halftone combinations:

- Vector drawings: Save as EPS or PDF files embedding the font or saving the text as "graphics."
- Color or grayscale photographs (halftones): Save as TIFF, JPG or PNG files using a minimum of 300 dpi (for single column: min. 1063 pixels, full page width: 2244 pixels).
- Bitmapped line drawings: Save as TIFF, JPG or PNG files using a minimum of 1000 dpi (for single column: min. 3543 pixels, full page width: 7480 pixels).
- Combinations bitmapped line/halftones (color or grayscale): Save as TIFF, JPG or PNG files using a minimum of 500 dpi (for single column: min. 1772 pixels, full page width: 3740 pixels).

Please do not submit:

- files that are too low in resolution (for example, files optimized for screen use such as GIF, BMP, PICT or WPG files).
- disproportionally large images compared to font size, as text may become unreadable.

Figure captions

All images must have a caption. A caption should consist of a brief title (not displayed on the figure itself) and a description of the image. We advise you to keep the amount of text in any image to a minimum, though any symbols and abbreviations used should be explained.

Provide captions in a separate file.

Color artwork

If you submit usable color figures with your accepted article, we will ensure that they appear in color online.

Please ensure that color images are accessible to all, including those with impaired color vision. Learn more about [color and web accessibility](#).

For articles appearing in print, you will be sent information on costs to reproduce color in the printed version, after your accepted article has been sent to production. At this stage, please indicate if your preference is to have color only in the online version of your article or also in the printed version.

Generative AI and Figures, images and artwork

Please read our policy on the use of generative AI and AI-assisted tools in figures, images and artwork, which can be found in Elsevier's [GenAI Policies for Journals](#). This policy states:

- We do not permit the use of Generative AI or AI-assisted tools to create or alter images in submitted manuscripts.
- The only exception is if the use of AI or AI-assisted tools is part of the research design or methods (for example, in the field of biomedical imaging). If this is the case, such use must be described in a reproducible manner in the methods section, including the name of the model or tool, version and extension numbers, and manufacturer.
- The use of generative AI or AI-assisted tools in the production of artwork such as for graphical abstracts is not permitted. The use of generative AI in the production of cover art may in some cases be allowed, if the author obtains prior permission from the journal editor and publisher, can demonstrate that all necessary rights have been cleared for the use of the relevant material, and ensures that there is correct content attribution.

Supplementary material

We encourage the use of supplementary materials such as applications, images and sound clips to enhance research. Some guidelines:

- Cite all supplementary files in the manuscript text.
- Submit supplementary materials at the same time as your article. Be aware that all supplementary materials provided will appear online in the exact same file type as received. These files will not be formatted or typeset by the production team.
- Include a concise, descriptive caption for each supplementary file describing its content.
- Provide updated files if at any stage of the publication process you wish to make changes to submitted supplementary materials.
- Do not make annotations or corrections to a previous version of a supplementary file.
- Switch off the option to track changes in Microsoft Office files. If tracked changes are left on, they will appear in your published version.

We recommend you upload research data to a suitable specialist or generalist repository. Please read our guidelines on [sharing research data](#) for more information on depositing, sharing and using research data and other relevant research materials.

Video

This journal accepts video material and animation sequences to support and enhance your scientific research. We encourage you to include links to video or animation files within articles. Some guidelines:

- When including video or animation file links within your article, refer to the video or animation content by adding a note in your text where the file should be placed.
- Clearly label files ensuring the given file name is directly related to the file content.
- Provide files in one of our [recommended file formats](#). Files should be within our preferred maximum file size of 150 MB per file, 1 GB in total.
- Provide "stills" for each of your files. These will be used as standard icons to personalize the link to your video data. You can choose any frame from your video or animation or make a separate image.
- Provide text (for both the electronic and the print version) to be placed in the portions of your article that refer to the video content. This is essential text, as video and animation files cannot be embedded in the print version of the journal.

We publish all video and animation files supplied in the electronic version of your article.

For more detailed instructions, we recommend that you read our guidelines on [submitting video content to be included in the body of an article](#).

Research data

We are committed to supporting the storage of, access to and discovery of research data, and our [research data policy](#) sets out the principles guiding how we work with the research community to support a more efficient and transparent research process.

Research data refers to the results of observations or experimentation that validate research findings, which may also include software, code, models, algorithms, protocols, methods and other useful materials related to the project.

Please read our guidelines on [sharing research data](#) for more information on depositing, sharing and using research data and other relevant research materials.

For this journal, the following instructions from our [research data guidelines](#) apply.

Option B: Research data deposit, citation and linking

You are **encouraged** to:

- Deposit your research data in a relevant data repository.
- Cite and link to this dataset in your article.
- If this is not possible, make a statement explaining why research data cannot be shared.

Data statement

To foster transparency, you are encouraged to state the availability of any data at submission.

Ensuring data is available may be a requirement of your funding body or institution. If your data is unavailable to access or unsuitable to post, you can state the reason why (e.g., your research data includes sensitive or confidential information such as patient data) during the submission process. This statement will appear with your published article on ScienceDirect.

Read more about the importance and benefits of providing a [data statement](#).

Data linking

Linking to the data underlying your work increases your exposure and may lead to new collaborations. It also provides readers with a better understanding of the described research.

If your research data has been made available in a data repository there are a number of ways your article can be linked directly to the dataset:

- Provide a link to your dataset when prompted during the online submission process.
- For some data repositories, a repository banner will automatically appear next to your published article on ScienceDirect.
- You can also link relevant data or entities within the text of your article through the use of identifiers. Use the following format: Database: 12345 (e.g. TAIR: AT1G01020; CCDC: 734053; PDB: 1XFN).

Learn more about [linking research data and research articles in ScienceDirect](#).

Article structure

Article sections

- Divide your article into clearly defined and numbered sections. Number subsections 1.1 (then 1.1.1, 1.1.2, ...), then 1.2, etc.
- Use the numbering format when cross-referencing within your article. Do not just refer to "the text."
- You may give subsections a brief heading. Headings should appear on a separate line.
- Do not include the article abstract within section numbering.

Glossary

Please provide definitions of field-specific terms used in your article, in a separate list.

Footnotes

We advise you to use footnotes sparingly. If you include footnotes in your article, ensure that they are numbered consecutively.

You may use system features that automatically build footnotes into text. Alternatively, you can indicate the position of footnotes within the text and present them in a separate section at the end of your article.

Acknowledgements

Include any individuals who provided you with help during your research, such as help with language, writing or proof reading, in the acknowledgements section. Acknowledgements should be placed in a separate section which appears directly before the reference list. Do not include acknowledgements on

your title page, as a footnote to your title, or anywhere else in your article other than in the separate acknowledgements section.

Funding sources

Authors must disclose any funding sources who provided financial support for the conduct of the research and/or preparation of the article. The role of sponsors, if any, should be declared in relation to the study design, collection, analysis and interpretation of data, writing of the report and decision to submit the article for publication. If funding sources had no such involvement this should be stated in your submission.

List funding sources in this standard way to facilitate compliance to funder's requirements:

Funding: This work was supported by the National Institutes of Health [grant numbers xxxx, yyyy]; the Bill & Melinda Gates Foundation, Seattle, WA [grant number zzzz]; and the United States Institutes of Peace [grant number aaaa].

It is not necessary to include detailed descriptions on the program or type of grants, scholarships and awards. When funding is from a block grant or other resources available to a university, college, or other research institution, submit the name of the institute or organization that provided the funding.

If no funding has been provided for the research, it is recommended to include the following sentence:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendices

We ask you to use the following format for appendices:

- Identify individual appendices within your article using the format: A, B, etc.
- Give separate numbering to formulae and equations within appendices using formats such as Eq. (A.1), Eq. (A.2), etc. and in subsequent appendices, Eq. (B.1), Eq. (B. 2) etc. In a similar way, give separate numbering to tables and figures using formats such as Table A.1; Fig. A.1, etc.

References

References within text

Any references cited within your article should also be present in your reference list and vice versa. Some guidelines:

- References cited in your abstract must be given in full.
- We recommend that you do not include unpublished results and personal communications in your reference list, though you may mention them in the text of your article.
- Any unpublished results and personal communications included in your reference list must follow the standard reference style of the journal. In substitution of the publication date add "unpublished results" or "personal communication."
- References cited as "in press" imply that the item has been accepted for publication.

Linking to cited sources will increase the discoverability of your research.

Before submission, check that all data provided in your reference list are correct, including any references which have been copied. Providing correct reference data allows us to link to abstracting

and indexing services such as Scopus, Crossref and PubMed. Any incorrect surnames, journal or book titles, publication years or pagination within your references may prevent link creation.

We encourage the use of Digital Object Identifiers (DOIs) as reference links as they provide a permanent link to the electronic article referenced.

Reference format

This journal does not set strict requirements on reference formatting at submission. Some guidelines:

- References can be in any style or format as long as the style is consistent.
- Author names, journal or book titles, chapter or article titles, year of publication, volume numbers, article numbers or pagination must be included, where applicable.
- Use of DOIs is recommended.

Our journal reference style will be applied to your article after acceptance, at proof stage. If required, at this stage we will ask you to correct or supply any missing reference data.

Reference style

All citations in the text should refer to:

- Single author: the author's name (without initials, unless there is ambiguity) and the year of publication.
- Two authors: both authors' names and the year of publication.
- Three or more authors: first author's name followed by 'et al.' and the year of publication.

Citations can be made directly (or parenthetically). Groups of references can be listed either first alphabetically, then chronologically, or vice versa. Examples: "as demonstrated (Allan, 2020a, 2020b; Allan and Jones, 2019)" or "as demonstrated (Jones, 2019; Allan, 2020). Kramer et al. (2023) have recently shown".

The list of references should be arranged alphabetically and then chronologically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters 'a', 'b', 'c', etc., placed after the year of publication.

Abbreviate journal names according to the [List of Title Word Abbreviations](#) (LTWA).

Examples:

Reference to a journal publication:

Van der Geer, J., Handgraaf, T., Lupton, R.A., 2020. The art of writing a scientific article. *J. Sci. Commun.* 163, 51–59. <https://doi.org/10.1016/j.sc.2020.00372>.

Reference to a journal publication with an article number:

Van der Geer, J., Handgraaf, T., Lupton, R.A., 2022. The art of writing a scientific article. *Heliyon*. 19, e00205. <https://doi.org/10.1016/j.heliyon.2022.e00205>.

Reference to a book:

Strunk Jr., W., White, E.B., 2000. *The Elements of Style*, fourth ed. Longman, New York.

Reference to a chapter in a book:

Mettam, G.R., Adams, L.B., 2023. How to prepare an electronic version of your article, in: Jones, B.S., Smith, R.Z. (Eds.), *Introduction to the Electronic Age*. E-Publishing Inc., New York, pp. 281–304.

Reference to a website:

Cancer Research UK, 2023. Cancer statistics reports for the UK.
<http://www.cancerresearchuk.org/aboutcancer/statistics/cancerstatsreport/> (accessed 13 March 2023).

Reference to a dataset:

Oguro, M., Imahiro, S., Saito, S., Nakashizuka, T., 2015. Mortality data for Japanese oak wilt disease and surrounding forest compositions [dataset]. Mendeley Data, v1.
<https://doi.org/10.17632/xwj98nb39r.1>.

Reference to software:

Coon, E., Berndt, M., Jan, A., Svyatsky, D., Atchley, A., Kikinzon, E., Harp, D., Manzini, G., Shelef, E., Lipnikov, K., Garimella, R., Xu, C., Moulton, D., Karra, S., Painter, S., Jafarov, E., & Molins, S., 2020. Advanced Terrestrial Simulator (ATS) v0.88 (Version 0.88) [software]. Zenodo.
<https://doi.org/10.5281/zenodo.3727209>.

Web references

When listing web references, as a minimum you should provide the full URL and the date when the reference was last accessed. Additional information (e.g. DOI, author names, dates or reference to a source publication) should also be provided, if known.

You can list web references separately under a new heading directly after your reference list or include them in your reference list.

Data references

We encourage you to cite underlying or relevant datasets within article text and to list data references in the reference list.

When citing data references, you should include:

- author name(s)
- dataset title
- data repository
- version (where available)
- year
- global persistent identifier

Add [dataset] immediately before your reference. This will help us to properly identify the dataset. The [dataset] identifier will not appear in your published article.

Preprint references

We ask you to mark preprints clearly. You should include the word "preprint" or the name of the preprint server as part of your reference and provide the preprint DOI.

Where a preprint has subsequently become available as a peer-reviewed publication, use the formal publication as your reference.

If there are preprints that are central to your work or that cover crucial developments in the topic, but they are not yet formally published, you may reference the preprint.

Reference management software

Most Elsevier journals have their reference template available in popular reference management software products. These include products that support [Citation Style Language \(CSL\)](#) such as [Mendeley Reference Manager](#).

If you use a citation plug-in from these products, select the relevant journal template and all your citations and bibliographies will automatically be formatted in the journal style. We advise you to [remove all field codes](#) before submitting your manuscript to any reference management software product.

If a template is not available for this journal, follow the format given in examples in the reference style section of this Guide for Authors.

Appendix B: PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Introduction
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Methods
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Methods
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Methods
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Methods
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Methods
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Methods
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Methods
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Methods
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Methods

Section and Topic	Item #	Checklist item	Location where item is reported
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Methods
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Methods
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Methods
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Methods
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Methods
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Methods
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Methods
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Results
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Results
Study characteristics	17	Cite each included study and present its characteristics.	Results
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Appendix
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Results
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Results
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Results
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Results
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Results
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Results
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Results
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussion

Section and Topic	Item #	Checklist item	Location where item is reported
	23b	Discuss any limitations of the evidence included in the review.	Discussion
	23c	Discuss any limitations of the review processes used.	Discussion
	23d	Discuss implications of the results for practice, policy, and future research.	Discussion
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Methods
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Methods
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Methods
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Title page
Competing interests	26	Declare any competing interests of review authors.	Statements and Declarations
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Statements and Declarations

Appendix C: Appraisal of cross-sectional studies (AXIS tool)

	Question	Yes	No	Don't know/ Comment
Introduction				
1	Were the aims/objectives of the study clear?			
Methods				
2	Was the study design appropriate for the stated aim(s)?			
3	Was the sample size justified?			
4	Was the target/reference population clearly defined? (Is it clear who the research was about?)			
5	Was the sample frame taken from an appropriate population base so that it closely represented the target/reference population under investigation?			
6	Was the selection process likely to select subjects/participants that were representative of the target/reference population under investigation?			
7	Were measures undertaken to address and categorise non-responders?			
8	Were the risk factor and outcome variables measured appropriate to the aims of the study?			
9	Were the risk factor and outcome variables measured correctly using instruments/measurements that had been trialled, piloted or published previously?			
10	Is it clear what was used to determine statistical significance and/or precision estimates? (e.g. p-values, confidence intervals)			
11	Were the methods (including statistical methods) sufficiently described to enable them to be repeated?			
Results				
12	Were the basic data adequately described?			
13	Does the response rate raise concerns about non-response bias?			
14	If appropriate, was information about non-responders described?			
15	Were the results internally consistent?			
16	Were the results presented for all the analyses described in the methods?			
Discussion				
17	Were the authors' discussions and conclusions justified by the results?			
18	Were the limitations of the study discussed?			
Other				

19	Were there any funding sources or conflicts of interest that may affect the authors' interpretation of the results?			
20	Was ethical approval or consent of participants attained?			

Appendix D: Psychology & Aging Instructions for Authors

Taken from : <https://www.apa.org/pubs/journals/pag>

Journal Article Reporting Standards

Authors must adhere to the [APA Style Journal Article Reporting Standards](#) (JARS). The standards offer ways to improve transparency in reporting to ensure that readers have the information necessary to evaluate the quality of the research and to facilitate collaboration and replication.

The JARS:

- Recommend the division of hypotheses, analyses, and conclusions into primary, secondary, and exploratory groupings to allow for a full understanding of quantitative analyses presented in a manuscript and to enhance reproducibility;
- Offer modules for authors reporting on replications, clinical trials, longitudinal studies, and observational studies, as well as the analytic methods of structural equation modeling and Bayesian analysis;
- Include guidelines on reporting of study preregistration (including making protocols public); participant characteristics (including demographic characteristics; inclusion and exclusion criteria) psychometric characteristics of outcome measures and other variables, and planned data diagnostics and analytic strategy.

Participant description, sample justification, and informed consent

Authors must include a detailed description of the study participants in the Method section of each empirical report, including the following:

- Age
- Sex / Gender
- Racial identity / Ethnicity

Authors are encouraged to include any other relevant demographics (e.g., nativity or immigration history; socioeconomic status; clinical diagnoses and comorbidities) as appropriate.

Authors are encouraged to justify their sample demographics and discuss the diversity of their study samples and the generalizability of their findings in the discussion section of the manuscript, and to appropriately temper conclusions in the abstract. If Western, educated, industrialized, rich, and democratic (WEIRD) or all-White samples are used, authors should justify their samples and describe their sample inclusion efforts (see Roberts, et al., 2020 for more information on justifying sample demographics). If age groups substantially differ in sample demographic, authors should discuss limitations to internal validity.

The method section also must include a statement describing how informed consent was obtained from the participants (and/or guardians), including for secondary use of data if applicable, and indicate that the study was conducted in compliance with an appropriate Internal Review Board.

Transparency and openness

APA endorses the Transparency and Openness Promotion (TOP) Guidelines developed by a community working group in conjunction with the Center for Open Science ([Nosek et al. 2015](#)). Reports of empirical research, including meta-analyses, submitted to *Psychology and Aging* must at least meet the “disclosure” level for all eight aspects of research planning and reporting, and the “requirement” level for Citation and for Transparency in Data, Design and Analysis, Analytic Code, and Research Materials. Thus, authors must make materials, deidentified data, and analytic code available via trusted repositories (e.g., [APA’s repository](#) on the Open Science Framework (OSF), or authors can access a full [list of other recommended repositories](#)), or explain the legal and/or ethical reasons that they cannot be provided. Trusted repositories adhere to policies that make data discoverable, accessible, usable, and preserved for the long term. Trusted repositories also assign unique and persistent identifiers.

We encourage investigators to preregister their research designs and analytic plans prior to conducting the research, but this is not required; if the study and analytic plans were not preregistered, this should be reported. There are many available preregistration forms (e.g., the APA [Preregistration for Quantitative Research in Psychology](#) template, [ClinicalTrials.gov](#), or other preregistration templates available via [OSF](#)); completed preregistration forms should be posted on a publicly accessible registry system (e.g., [OSF](#), [ClinicalTrials.gov](#), or other trial registries in the WHO Registry Network). The list below presents the eight fundamental aspects of research planning and reporting, the TOP level required by *Psychology and Aging*. Authors are encouraged to use the [Psychology and Aging TOP Checklist](#) to verify adherence to these standards before submission.

- Citation: Level 2, Requirement—All data, program code, and other methods developed by others must be cited in the text and listed in the references section.
- Data Transparency: Level 2, Requirement—Article states whether the raw and/or processed data on which study conclusions are based are posted to a trusted repository and either how to access them or the legal or ethical reasons why they are not available.
- Analytic Methods (Code) Transparency: Level 2, Requirement—Article states where computer code or syntax needed to reproduce analyses is posted to a trusted repository and how to access it. The legal or ethical reason for any exception must be explained in the article.
- Research Materials Transparency: Level 2, Requirement—Article states where materials described in the method section are posted to a trusted repository and how to access it. The legal or ethical reason for any exception must be explained in the article.
- Design and Analysis Transparency (Reporting Standards): Level 2, Requirement—The article must report 1) how the sample size was determined, 2) the gender and racial distribution of the sample as a function of age, 3) all data exclusions, 4) all manipulations, and 5) all study measures (see the [APA Journal Article Reporting Standards; JARS](#) and Simmons, Nelson, & Simonsohn, 2012).
- Study Preregistration: Level 1, Disclosure—Article states whether the study design and hypotheses were preregistered and, if so, how to access them. For masked submissions, authors may provide a masked version via a stable link or supplemental material.
- Analysis Plan Preregistration: Level 1, Disclosure—Article states whether any of the work reported preregistered an analysis plan and, if so, how to access it. For masked submissions, authors may provide a masked version via stable link or supplemental material.
- Replication: Level 1, Disclosure—The journal publishes replications.

Authors should include an introductory subsection in the method section titled “Transparency and openness.” This subsection should include a statement that materials, deidentified data, and analytic code are available—or an explanation of the legal and/or ethical reasons for any exceptions. This subsection should also include a statement as to whether or not the design and/or analytic plan were preregistered. Some examples of transparency and openness statements are as follows.

- We report how we determined our sample size, and describe all data exclusions, manipulations, and all measures in the study, and we follow the JARS (Appelbaum et al., 2018). All data, analysis code, and research materials are available. Data were analyzed using R, version 4.0.0 (R Core Team, 2020) and the package *ggplot*, version 3.2.1 (Wickham, 2016). This study’s design and its analysis were not pre-registered.
- We report how we determined our sample size and describe all manipulations and measures that were collected, as described in our pre-registration. No data met our a priori exclusion criteria (described below), so analyses reported are based on all data that were collected. Deidentified data and analysis code are available. Stimulus materials are copyright protected and cannot be provided.

Manuscript preparation

Prepare manuscripts according to the 7th edition of the [*Publication Manual of the American Psychological Association*](#), paying attention to the use of bias-free language (see Chapter 5). Additional guidance can be found in APA's [Journal Manuscript Preparation Guidelines](#) and on the [APA Style website](#).

Double-space all copy. Other formatting instructions, as well as instructions on page numbering, preparing tables, figures, references, metrics, and the abstract, appear in the *Manual*.

Prior to submission, download the [Editorial Submission Checklist for Psychology and Aging](#). Complete this checklist and copy-paste into the cover for the submission.

Length

Articles

Articles do not typically exceed 8,000 words, excluding references, tables, and figures. Shorter manuscripts are equally welcome.

Articles exceeding the 8,000 word limit may be considered if they offer an especially novel theoretical framework, or complex methodology or statistical approach that requires more extensive exposition.

Psychology and Aging publishes direct replications. Submissions should include “A Replication of XX Study” in the subtitle of the manuscript as well as in the abstract.

Brief Reports

The Brief Report format is reserved for particularly “crisp,” theoretically noteworthy contributions that meet the highest methodological standards.

Brief reports are typically no longer than 3,500 words, excluding references, tables, and figures, and include no more than two tables or figures.

Papers in this format differ in length from regular articles, but not in rigor.

Below are additional instructions regarding the preparation of display equations, computer code, and tables.

Title page

The first manuscript page is a title page, which includes a title of no more than 12 words, the author byline and institutional affiliation(s) where the work was conducted, a running head with a maximum of 50 characters (including spaces), and the author note.

Abstract, Public Significance Statements, and keywords

All manuscripts must include an abstract, Public Significance Statement, and up to five keywords or brief phrases, typed on a separate page after the title page.

The abstract provides a balanced summary of the paper's objectives, methods, findings, and conclusions (cf. [APA Style Journal Article Reporting Standards](#)) and should be comprehensible to a general audience of psychological scientists. Abstracts are no longer than 250 words.

The Public Significance Statement describes the most central finding(s) that will be easily understood by the larger public (e.g., practitioners, educators, policy makers, and news media), as well as the implications for theory, application, and/or policy. The Public Significance statement is typically one to three sentences in length and 30 to 70 words long (further guidance and examples can be found [here](#)).

References

List references in alphabetical order. Each listed reference should be cited in text, and each text citation should be listed in the references section.

Examples of basic reference formats:

Journal article

McCauley, S. M., & Christiansen, M. H. (2019). Language learning as language use: A cross-linguistic model of child language development. *Psychological Review*, 126(1), 1–51. <https://doi.org/10.1037/rev0000126>

Authored book

Brown, L. S. (2018). *Feminist therapy* (2nd ed.). American Psychological Association. <https://doi.org/10.1037/0000092-000>

Chapter in an edited book

Balsam, K. F., Martell, C. R., Jones, K. P., & Safren, S. A. (2019). Affirmative cognitive behavior therapy with sexual and gender minority people. In G. Y. Iwamasa & P. A. Hays (Eds.), *Culturally responsive cognitive behavior therapy: Practice and supervision* (2nd ed., pp. 287–314). American Psychological Association. <https://doi.org/10.1037/0000119-012>

All data, program code, and other methods must be cited in the text and listed in the references section.

Data set citation

Alegria, M., Jackson, J. S., Kessler, R. C., & Takeuchi, D. (2016). Collaborative Psychiatric Epidemiology Surveys (CPES), 2001–2003 [Data set]. Inter-university Consortium for Political and Social Research. <https://doi.org/10.3886/ICPSR20240.v8>

Software/Code citation

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, 36(3), 1–48. <https://www.jstatsoft.org/v36/i03/>

Wickham, H. et al., (2019). Welcome to the tidyverse. *Journal of Open Source Software*, 4(43), 1686, <https://doi.org/10.21105/joss.01686>

Figures

Preferred formats for graphics files are TIFF and JPG, and preferred format for vector-based files is EPS. Graphics downloaded or saved from web pages are not acceptable for publication. Multipanel figures (i.e., figures with parts labeled a, b, c, d, etc.) should be assembled into one file. When possible, please place symbol legends below the figure instead of to the side.

Resolution

- All color line art and halftones: 300 DPI
- Black and white line tone and gray halftone images: 600 DPI

Line weights

- Adobe Photoshop images
- a. Color (RGB, CMYK) images: 2 pixels
 - b. Grayscale images: 4 pixels
- Adobe Illustrator Images
- a. Stroke weight: 0.5 points

APA offers authors the option to publish their figures online in color without the costs associated with print publication of color figures.

The same caption will appear on both the online (color) and print (black and white) versions. To ensure that the figure can be understood in both formats, authors should add alternative wording (e.g., “the red (dark gray) bars represent”) as needed.

For authors who prefer their figures to be published in color both in print and online, original color figures can be printed in color at the editor's and publisher's discretion provided the author agrees to pay:

- \$900 for one figure
- An additional \$600 for the second figure
- An additional \$450 for each subsequent figure

Display equations

We strongly encourage you to use MathType (third-party software) or Equation Editor 3.0 (built into pre-2007 versions of Word) to construct your equations, rather than the equation support that is built into Word 2007 and Word 2010. Equations composed with the built-in Word 2007/Word 2010 equation support are converted to low-resolution graphics when they enter the production process and must be rekeyed by the typesetter, which may introduce errors.

To construct your equations with MathType or Equation Editor 3.0:

- Go to the Text section of the Insert tab and select Object.
- Select MathType or Equation Editor 3.0 in the drop-down menu.

If you have an equation that has already been produced using Microsoft Word 2007 or 2010 and you have access to the full version of MathType 6.5 or later, you can convert this equation to MathType by clicking on MathType Insert Equation. Copy the equation from Microsoft Word and paste it into the MathType box. Verify that your equation is correct, click File, and then click Update. Your equation has now been inserted into your Word file as a MathType Equation.

Use Equation Editor 3.0 or MathType only for equations or for formulas that cannot be produced as Word text using the Times or Symbol font.

Computer code

Because altering computer code in any way (e.g., indents, line spacing, line breaks, page breaks) during the typesetting process could alter its meaning, we treat computer code differently from the rest of your article in our production process. To that end, we request separate files for computer code.

In online supplemental material

We request that runnable source code be included as supplemental material to the article. For more information, visit [Supplementing Your Article With Online Material](#).

In the text of the article

If you would like to include code in the text of your published manuscript, please submit a separate file with your code exactly as you want it to appear, using Courier New font with a type size of 8 points. We will make an image of each segment of code in your article that exceeds 40 characters in length. (Shorter snippets of code that appear in text will be typeset in Courier New and run in with the rest of the text.) If an appendix contains a mix of code and explanatory text, please submit a file that contains the entire appendix, with the code keyed in 8-point Courier New.

Tables

Use Word's insert table function when you create tables. Using spaces or tabs in your table will create problems when the table is typeset and may result in errors.

Appendix E: School of Psychology Ethics Committee Approval (Significant Amendments from Supervisor)

University of East Anglia

Study title: Examining personal semantics within the autobiographical interview

Application ID: ETH2223-2509 (Amendment prior to EM)

Dear Louis,

Your application was considered on 15th June 2023 by the PSY S-REC (School of Psychology Research Ethics Subcommittee).

The **decision** is: **approved**.

You are therefore able to start your project subject to any other necessary approvals being given.

This approval will expire on **31st July 2024**.

Please note that your project is granted ethics approval only for the length of time identified above. Any extension to a project must obtain ethics approval by the PSY S-REC (School of Psychology Research Ethics Subcommittee) before continuing.

It is a requirement of this ethics approval that you should report any adverse events which occur during your project to the PSY S-REC (School of Psychology Research Ethics Subcommittee) as soon as possible. An adverse event is one which was not anticipated in the research design, and which could potentially cause risk or harm to the participants or the researcher, or which reveals potential risks in the treatment under evaluation. For research involving animals, it may be the unintended death of an animal after trapping or carrying out a procedure.

Any amendments to your submitted project in terms of design, sample, data collection, focus etc. should be notified to the PSY S-REC (School of Psychology Research Ethics Subcommittee) in advance to ensure ethical compliance. If the amendments are substantial a new application may be required.

Approval by the PSY S-REC (School of Psychology Research Ethics Subcommittee) should not be taken as evidence that your study is compliant with the UK General Data Protection Regulation (UK GDPR) and the Data Protection Act 2018. If you need guidance on how to make your study UK GDPR compliant, please contact the UEA Data Protection Officer (dataprotection@uea.ac.uk).

I would like to wish you every success with your project.

On behalf of the PSY S-REC (School of Psychology Research Ethics Subcommittee)

Yours sincerely,

Thomas Sambrook

Ethics ETH2223-2509 (Significant amendments): Dr Louis Renoult

Appendix F: Screening Measures

The Generalised Anxiety Disorder Assessment (GAD-7)

GAD-7

Over the <u>last 2 weeks</u> , how often have you been bothered by any of the following problems?	Not at all	Several days	More than half the days	Nearly every day
1. Feeling nervous, anxious, or on edge	0	1	2	3
2. Not being able to stop or control worrying	0	1	2	3
3. Worrying too much about different things	0	1	2	3
4. Trouble relaxing	0	1	2	3
5. Being so restless that it's hard to sit still	0	1	2	3
6. Becoming easily annoyed or irritable	0	1	2	3
7. Feeling afraid as if something awful might happen	0	1	2	3

The Patient Health Questionnaire (PHQ-9)

PHQ-9

Over the <u>last 2 weeks</u> , how often have you been bothered by any of the following problems?	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself — or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead or of hurting yourself in some way	0	1	2	3

Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. **Please answer all questions.**

1. During the past month, what time have you usually gone to bed at night? _____
2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night? _____
3. During the past month, what time have you usually gotten up in the morning? _____
4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.) _____

5. During the <u>past month</u> , how often have you had trouble sleeping because you...	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe:				
6. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
	No problem at all	Only a very slight problem	Somewhat of a problem	A very big problem
8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?				
	Very good	Fairly good	Fairly bad	Very bad
9. During the past month, how would you rate your sleep quality overall?				

The Addenbrookes Cognitive Examination Scale

ADDENBROOKE'S COGNITIVE EXAMINATION – ACE-III UK Version C (2012)																								
Name: _____			Date of testing: ____ / ____ / ____																					
Date of Birth: _____			Tester's name: _____ Age _____																					
Hospital No. or Address: _____			at leaving full-time education: _____																					
			Occupation: _____																					
			Handedness: _____																					
ATTENTION *(Sum together only the items in BOLD for the M-ACE score)																								
➤ Ask: What is the	Day _____	Date _____	Month _____	Year _____	Season _____	Attention [Score 0-5] * Attention [Score 0-5] 																		
➤ Ask: Which	No./Floor _____	Street/Hospital _____	Town _____	County _____	Country _____																			
ATTENTION																								
➤ Tell: "I'm going to give you three words and I'd like you to repeat them after me: shoe, flag, tree." After subject repeats, say "Try to remember them because I'm going to ask you later". ➤ Score <i>only</i> the first trial (repeat 3 times if necessary). ➤ Register number of trials: _____						Attention [Score 0-3] 																		
ATTENTION																								
➤ Ask the subject: "Could you take 7 away from 100? I'd like you to keep taking 7 away from each new number until I tell you to stop." ➤ If subject makes a mistake, do not stop them. Let the subject carry on and check subsequent answers (e.g., 93, 84, 77, 70, 63 – score 4). ➤ Stop after five subtractions (93, 86, 79, 72, 65): _____						Attention [Score 0-5] 																		
MEMORY																								
➤ Ask: 'Which 3 words did I ask you to repeat and remember?' _____						Memory [Score 0-3] 																		
FLUENCY																								
➤ Letters Say: "I'm going to give you a letter of the alphabet and I'd like you to generate as many words as you can beginning with that letter, but not names of people or places. For example, if I give you the letter "C", you could give me words like "cat, cry, clock" and so on. But, you can't give me words like Catherine or Canada. Do you understand? Are you ready? You have one minute. The letter I want you to use is the letter "P".						Fluency [Score 0 – 7]																		
						<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>≥ 18</td><td>7</td></tr> <tr><td>14-17</td><td>6</td></tr> <tr><td>11-13</td><td>5</td></tr> <tr><td>8-10</td><td>4</td></tr> <tr><td>6-7</td><td>3</td></tr> <tr><td>4-5</td><td>2</td></tr> <tr><td>2-3</td><td>1</td></tr> <tr><td>0-1</td><td>0</td></tr> <tr><td>total</td><td>correct</td></tr> </table>	≥ 18	7	14-17	6	11-13	5	8-10	4	6-7	3	4-5	2	2-3	1	0-1	0	total	correct
≥ 18	7																							
14-17	6																							
11-13	5																							
8-10	4																							
6-7	3																							
4-5	2																							
2-3	1																							
0-1	0																							
total	correct																							
➤ Animals Say: "Now can you name as many animals as possible. It can begin with any letter."						Fluency [Score 0 – 7]																		
						<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>≥ 22</td><td>7</td></tr> <tr><td>17-21</td><td>6</td></tr> <tr><td>14-16</td><td>5</td></tr> <tr><td>11-13</td><td>4</td></tr> <tr><td>9-10</td><td>3</td></tr> <tr><td>7-8</td><td>2</td></tr> <tr><td>5-6</td><td>1</td></tr> <tr><td><5</td><td>0</td></tr> <tr><td>total</td><td>correct</td></tr> </table>	≥ 22	7	17-21	6	14-16	5	11-13	4	9-10	3	7-8	2	5-6	1	<5	0	total	correct
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14-16	5																							
11-13	4																							
9-10	3																							
7-8	2																							
5-6	1																							
<5	0																							
total	correct																							

MEMORY

- Tell: "I'm going to give you a name and address and I'd like you to repeat the name and address after me. So you have a chance to learn, we'll be doing that 3 times. I'll ask you the name and address later."

Memory
[Score 0 – 7]

Score only the third trial.

	<i>1st Trial</i>	<i>2nd Trial</i>	<i>3rd Trial</i>
John Marshall 24	_____	_____	_____
Market Street	_____	_____	_____
Spilsby	_____	_____	_____
Lincolnshire	_____	_____	_____

MEMORY

- Name of the current Prime Minister.....
- Name of the first female Prime Minister
- Name of the USA president.....
- Name of the USA president who was assassinated in the 1960s.....

Memory
[Score 0 – 4]

LANGUAGE

- Place a pencil and a piece of paper in front of the subject. As a practice trial, ask the subject to "**Pick up the pencil and then the paper.**" If incorrect, score 0 and do not continue further.
- If the subject is correct on the practice trial, continue with the following three commands below.
- Ask the subject to "**Place the paper on top of the pencil**"
 - Ask the subject to "**Pick up the pencil but not the paper**"
 - Ask the subject to "**Pass me the pencil after touching the paper**"
- Note: Place the pencil and paper in front of the subject before each command.

Language
[Score 0-3]

LANGUAGE

- Say: "I want you to write two sentences. It can be about anything that you like. I want you to write in full sentences and avoid abbreviations." If the subject does not know what to write about, you could suggest a few topics. "For instance, you could write about a recent holiday, your hobbies, your family or childhood." If the subject writes only one sentence, then prompt for a second one.

Language
[Score 0-2]

Sentences must contain a subject and a verb. Spelling and grammar are penalized. Sentences do not need to be about the same topic. See scoring guidelines for more information.

LANGUAGE

- Ask the subject to repeat: '**caterpillar**'; '**eccentricity**'; '**unintelligible**'; '**statistician**'
- Score 2 if all are correct; score 1 if 3 are correct; and score 0 if 2 or less are correct.

Language
[Score 0-2]

LANGUAGE

- Ask the subject to repeat: 'All that glitters is not gold'

Language
[Score 0-1]

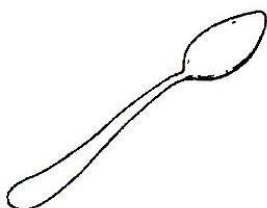
- Ask the subject to repeat: 'A stitch in time saves nine'

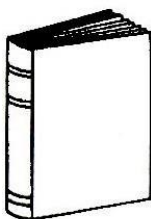
Language
[Score 0-1]

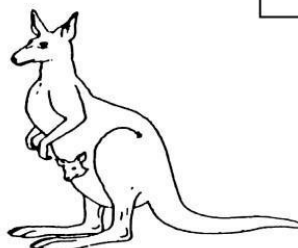
LANGUAGE

- Ask the subject to name the following pictures:

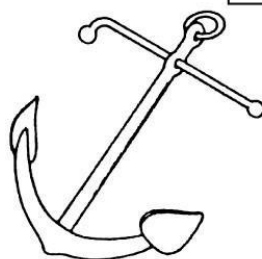
Language
[Score 0-12]

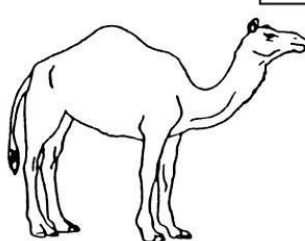




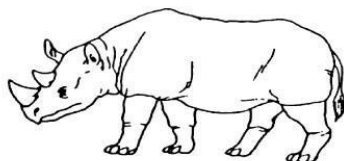








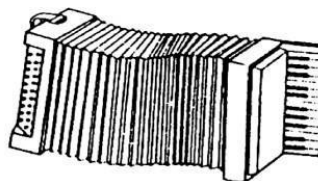












LANGUAGE

- Using the pictures above, ask the subject to:

Language
[Score 0-4]

- Point to the one which is associated with the monarchy
- Point to the one which is a marsupial
- Point to the one which is found in the Antarctic
- Point to the one which has a nautical connection

LANGUAGE

- Ask the subject to read the following words: (Score 1 only if all correct)

sew pint soot doughheight

Language

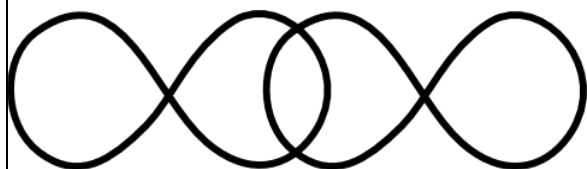
[Score 0-1]

VISUOSPATIAL ABILITIES

- Infinity Diagram: Ask the subject to copy this diagram.

Visuospatial

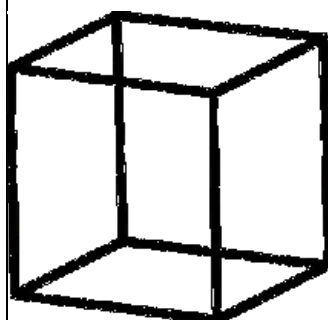
[Score 0-1]



- Wire cube: Ask the subject to copy this drawing (for scoring, see instructions guide).

Visuospatial

[Score 0-2]



- Clock: Ask the subject to draw a clock face with numbers. Then, ask the subject to put the hands at ten past five. (For scoring see instruction guide: circle = 1, numbers = 2, hands = 2 if all correct).

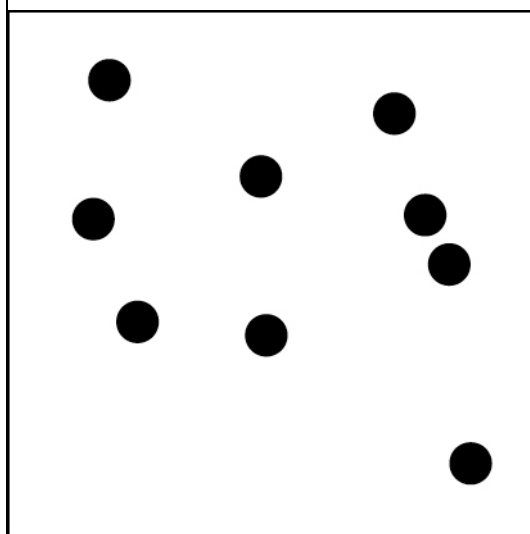
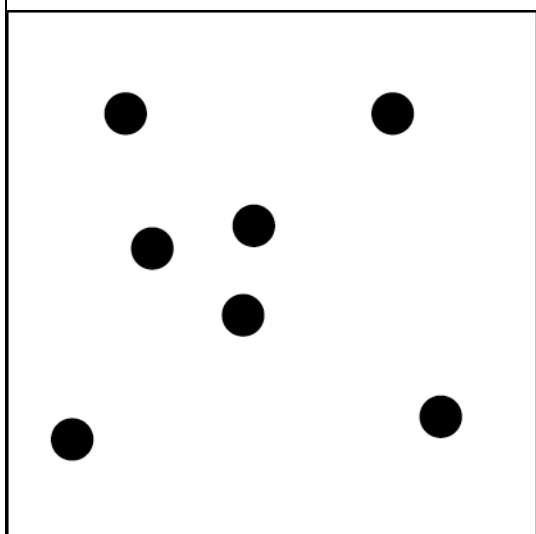
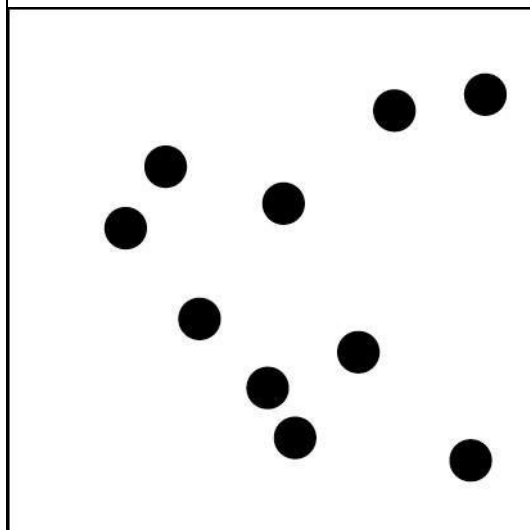
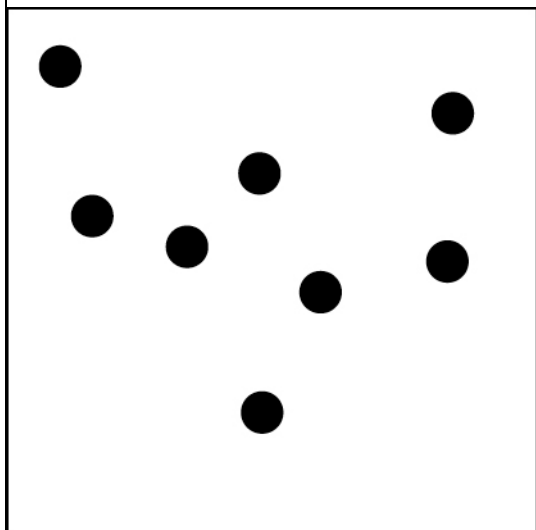
Visuospatial

[Score 0-5]

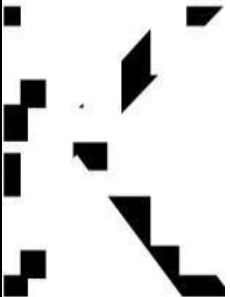
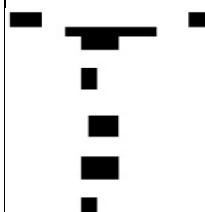
VISUOSPATIAL ABILITIES

➤ Ask the subject to count the dots without pointing to them

Visuospatial
[Score 0-4]



VISUOSPATIAL ABILITIES

➤ Ask the subject to identify the letters		Visuospatial [Score 0-4]
 	 	
 	 	

MEMORY

➤ Ask "Now tell me what you remember about that name and address we were repeating at the beginning"		Memory [Score 0-7]
John Marshall 24 Market Street Spilsby Lincolnshire		

MEMORY

➤ This test should be done if the subject failed to recall one or more items above. If all items were recalled, skip the test and score 5. If only part was recalled start by ticking items recalled in the shadowed column on the right hand side; and then test not recalled items by telling the subject "ok, I'll give you some hints: was the name X, Y or Z?" and so on. Each recognised item scores one point, which is added to the point gained by recalling.		Memory [Score 0-5] 		
John Simons	John Marshall	Joseph Marshall	recalled	
42	28	24	recalled	
Market Street	High Street	Market Square	recalled	
Spilsby	Horncastle	Sleaford	recalled	
Northamptonshire	Lincolnshire	Leicestershire	recalled	

SCORES

TOTAL ACE-III SCORE		/100
TOTAL M-ACE SCORE		/30
Attention		/18
Memory		/26
Fluency		/14
Language		/26
Visuospatial		/16

Appendix G: Interview instructions (AI, P-SAI and G-SAI)

Autobiographical Interview- Administration Manual (Brian Levine, Eva Svoboda and Morris Moscovitch, 2005)

Autobiographical Interview Administration manual

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General guidelines

Defining an event with multiple levels of probing

This interview is conducted in three parts: Recall, General Probe and Specific Probe. To avoid contamination of subsequent events by Specific Probe, Recall and General probe are conducted for all five events, then the examiner goes back to the first event and conducts Specific Probing for all five events. The interview must be audiotaped and transcribed for scoring.

During Recall, the examiner does not unduly influence the recollection. Simply read the instructions and let the subject talk and be sure they are through before you say anything.

The purpose of General Probe is to help the subject focus in on a single event if they have given non-specific information during recall, or if they have misunderstood some other aspect of the instructions. At this level do not refer to time, place, emotion, or other details. Choose from among the probes (listed under General Probe instructions) depending on subjects' recall response; do not use other probes. If a specific event is described in Recall (i.e., a few hours in duration, specific in time and place, and not an event that was repeated several times) that is rich in detail, general probing is not necessary. If in doubt, though, it is better to probe.

In Specific Probe, the examiner has more liberty, as long as he or she is working with what the subject has produced (i.e., do not ask the subject about something that they did not raise on their own). At the start of Specific Probe, a “story” should be clearly established. That is, there should be a clear

event with a beginning and ending and something in the middle. If this was not achieved after general probing, start specific probing by eliciting episodic detail information. In other words probe for event details or find out what happened, and if there is a defined or localized event that can be further probed with more specificity (time, place, emotion etc.). In some cases it can be helpful to start Specific Probe by eliciting time and place information (or other details, depending on the event), followed by probing for event details. If no clear event is forthcoming, the event list is used to cue memories.

Instructions

I am going to ask you to tell me about an event from each of these time periods of your life.

PRESENT TIME PERIODS SHEET. NOTE THERE ARE TWO CHOICES DEPENDING ON AGE OF SUBJECT. FOR STIMULUS-BOUND OR HIGHLY DISTRACTIBLE SUBJECTS, DO NOT PRESENT TIME PERIODS SHEET.

You can choose any events you wish. I will ask you to describe the events, then I will ask you some questions about them. To help with scoring, we will be audiotaping your responses. Otherwise, your responses will be kept completely confidential and your tape will be assigned a subject number and stored in a secure place.

The event must be one you were personally involved in, and you must have a recollection of being personally involved. Do not pick events that you heard about from others. They must be events from a specific time and place. For example, describing a 3 week vacation would not be sufficient. However, a specific incident that happened on one day during your vacation would be good. I want you to provide as much detail as you can about the event.

Our interest is not so much in which events you choose, but rather how you describe them. So do not feel pressured to pick any particular event. I want you to know that I will be asking you to give some details for these events later, so be sure to only choose events that you feel comfortable discussing in detail.

For each event, collect Recall, then General Probe responses. After events from each period have been collected, administer Specific Probes for each event.

RECALL

Let's start with the first one.

- **Tell me about an event that happened at a specific time and place during the childhood period.**

Record as much information as you can from the subject's response on the record sheet, so you can follow up on it if necessary. In recall it is important to allow the subject to speak until they have finished without structuring or guiding their response in any way. Therefore, simply let the subject talk until they are finished. The only exception is if a subject shows no signs of stopping after a 5-minute monologue. You should therefore be prepared to time loquacious participants and to end Recall once 5 minutes have elapsed.

The only acceptable cues during Recall are **“Go ahead”** or **“Yes”**. If the subject asks for clarification, it is OK to answer based on the above instructions, but do not provide additional information. If a clearly inappropriate response is provided (i.e., wrong time period), the examiner should ask the subject to provide another event. However, if a “semantic” response was provided (i.e., correct time period but no defined event) simply go on to General Probe.

For each time period work the term “specific event” or “an event specific to time and place” into the instructions (see above). This reminds the subject of the key instructions given during the introduction.

GENERAL PROBING

There are three likely scenarios that arise after recall.

1) The subject provides a detailed account of an event specific to time and place.

Solution: No probing is necessary here, move on to the next time period. (If in doubt give one of the probes listed below)

2) Some subjects provide a terse or vague description of a specific event.

Solution: Use the following probes for eliciting more details. These subjects may need encouragement or a cue to give a full account of what happened.

- **Is there anything else you can tell me?**
- **Tell me more about it.**
- **Tell me more details about**
- **What do you remember about?**
- **Is that everything you can say about it? I want to know all the details that come to mind.**

If the subject reiterates what was said or begins recalling another incident in response to the probe, this may indicate that most of the available information has been produced.

3) Some subjects may have trouble distinguishing specific from general events (i.e., they only give semantic information).

Solution: If a specific event was not provided during recall, say,

- **That's not quite what I was looking for. I need a memory for a single event or instance that happened to you.**
- **Can you tell me about an incident that happened at a particular time and place?**

Overall general probing tips:

If necessary verify that an incident is specific to time and place, rather than a generic description of an event that occurred over several occasions.

- **Is this something that happened to you more than once?**
(if yes, say)
- **Can you tell me about a specific instance of.....?**
- **Tell me about one particular time ... that you ...**

If the subject continues to have difficulty retrieving a specific event, it may be necessary to give them the opportunity to select another event. This can be done in two ways – more weight is placed on the former if it is applicable.

1) The subject recalls more than one episode during recall that are vague or generic.

Solution: Provide guidance by asking them to focus on one of those episodes. However, be careful to let the subject select the event, rather than asking them leading questions.

You mentioned a number of events (*if necessary list events*). Now I want you to pick just one of them. Choose the one that you can tell me the most about.

- 2) If the subject provides a severely impoverished recollection and you feel that more details could be recalled if another event was selected, say,

Would you like to choose another event?

During Recall and General Probe, note information that corresponds to categories on the specific probing sheet, so that these queries are not repeated during Specific Probe.

The overall goal of General Probe is to remind the subject that we are looking for an event that occurred at a specific time and place. Do not provide any other guidance such as telling the subject which event to focus on, or asking for details that will be elicited during Specific Probe. If the subject is unable to provide a specific event after three attempts at general probing, move on to the next time period. It is OK to move on without getting a specific event. However, before doing so you should be convinced that the reason is because the subject is unable to provide a recollection through general probing, rather than a misunderstanding of what we are looking for. As with Recall, impose a five-minute time limit after each cue in General Probe.

SPECIFIC PROBING

There are three components to specific probing: establishing the event or "story", specific probes, and ratings.

- 1) The first component is considered probing for event details. The goal is to clearly establish an event that is both scorable and clearly described - in other words to get a clear description of what happened. The amount of probing at this stage will depend on what was produced in Recall and General Probe.

Event WAS recalled...

If the subject produced a richly detailed episode, it is not necessary to do this additional probing; the examiner can move directly into the specific questions.

If a clear event was described, but lacking in episodic detail, work with the subject's earlier response to establish the "story." Focus the subject based on the content of their earlier response with questions like, **"You said XXX happened. What happened next? I want to know as**

many details as you can recall.” Specific questions may be asked based on the content of the response (e.g., **What did she say to you?**), but only ask about aspects that are clearly central to the recollected event based on what the subject said. Try not to be influenced by your own personal judgement about what is important in the event.

Event was NOT recalled...

If no specific event was provided at all in Recall/General Probe, reiterate the instructions (e.g., we’re looking for an event specific to time and place). It is often helpful to summarize the responses given during Recall/General Probe, which may result in the selection of a workable event (see above). If no event is produced with this probing, then use the event list to cue a specific event (see below).

Instructions for event list

Let's see if this list can trigger any memories. For _____(insert time period), read the list and choose an event that you can tell me about. Additionally, it is OK to describe any event of which you are reminded when you see the cue, even if the event is only partially related to the cue.

For the new event selected from the list, treat the initial response as a recall response. Administer general probes, then go on to specific probes.

Occasionally it will be revealed that the subject’s original event is not acceptable, for example from the wrong time period. In this case, ask for a new event, using the event list if they cannot come up with anything.

2) Query each major (bold) item on the specific probing sheet that was not covered in Recall/General Probe. The items can be adjusted based on the event, but try to sample all five senses. Many subjects will come up with sensory information upon query that would not be expected on the basis of the earlier response. For items that have already been covered, ask, "Is there anything else you can tell me about _____ that you haven't told me already."

Be careful not to lead the subject in querying these items. Some subjects will feel inclined to generate a response simply because you asked. If you sense this is happening, clarify that you do

not expect that they will necessarily have a memory for each question, but that you will ask them all just to find out if they do. If you feel the subject has reflexively responded based on the fact you queried not based upon a real memory, ask them if they really remember it. Similarly, a subject may make a statement that is inferred, rather than a recollection ("It must have been cold because it was December.") In this case, ask the subject if they actually recollect this or they are simply assuming without a direct recollection.

- **Are you guessing?**
- **Do you actually remember that happening?**

Because the scoring system for this measure is not concerned with the sequence of probed information within an event, it is not required that the specific probes be administered in a fixed order. In many cases it can be useful to probe for specific details (time, place) while trying to establish the story as described above.

3) With the exception of the first group of specific probes (place localization) there is also an accompanying or independent subjective rating component. These ratings tap perceptual re-experiencing, emotionality, personal importance “then” and “now”, and mental/verbal rehearsal of the episode. When you get to the rating components show the subject the accompanying cue sheet to aid them in making their rating. For the rehearsal rating, read out the 6 available options on the cue sheet for the first memory, and summarize it for the others. Do not guide their response to what you think would be the appropriate rating based on their recollection.

Pt. ID: _____ Date: _____ Examiner: _____ Memory #: _____

Recall

General Probe

Specific probing
(If necessary, work
with subject to
establish the “story”
before proceeding to
specific cues below).

Was event list used? Yes _____ No _____

**When did this event
take place?**

Year

Month/Season

Date/time of month	
Day of week	
Time of day	
Where did this take place?	
Country	
Region/State/Province	
City	
Street	
Address/Building	
Room/Part of building	
Part of room	
Perceptual	
Objects ("Do you have any visual images associated with this memory?", objects)	
Colors	
Sounds	
Smells	
Tastes	
Physical sensations (e.g., textures, pain, temperature)	
Body position in relation to others	
Body position (sitting/standing)	
Event duration	
How clearly can you visualize this event?	1 Vague memory No recollection 2 3 4 5 6 Extremely clear as if it were happening now

Can you tell me anything about what you were thinking or feeling at the time?						
Feelings						
Thoughts/Implications						
Expressed emotion						
How much did your emotional state change from before the event occurred to after it happened?	1	2	3	4	5	6
	No change in how I felt			Underwent tremendous emotional change		
Personal Importance						
How personally important is this event to you now?	1	2	3	4	5	6
	No importance at all			Of great importance		
How personally important was this event to you then ?	1	2	3	4	5	6
	No importance at all			Of great importance		

Rehearsal						
On average, how often do you think or talk about this event?	1	2	3	4	5	6
	(see cue sheet)					

Choose events that happened to you at a specific time and place

Early memories

First memory
Buying a pet
Birthday party
A sibling's birth
Playing a game during childhood

Emotional

Losing something important
Being humiliated
An argument
Being fired
Pet dying
Being disciplined at school
Being very frightened
Performance failure
A bad play (sports)
Being robbed/burglarized
Injury or illness in a friend
Being lost
Witnessing an accident

Family events

Someone's death
A Wedding
Birth - own children
Birth - family/friend
A holiday celebration
Injury or illness in a family member
First day of school for child
Spousal argument
A celebration from childhood
A family reunion

Job Related

A job interview
Speaking in public
Being promoted/given a raise
Making a mistake on the job
First job
First paycheck
Retirement
Military service

Leisure

Shooting a gun
Going to a sporting event
Going to a performance
A significant movie or play
A memorable meal

Romance

First kiss
First date
Falling in love
Holding hands/romantic touching

Misbehavior

Catching someone doing something
Being arrested, stopped by police
Using drugs
Stealing something
Doing something dangerous
Breaking something valuable
Telling a lie
Cheating on a test
Being caught doing something wrong
Trying a cigarette for the first time

Physical

A hospitalization/operation
Being hurt or injured
A fight
Being sick
Being disciplined
Car accident
Getting sick on alcohol
Pregnancy
Getting food poisoning
A doctor or dentist appointment

Public

Seeing someone famous
Being on TV, radio, or newspaper
Disaster (natural or man-made)

Religious

1st holy communion
1st Confession
Confirmation/bar mitvah

School

Taking a test (school or standardized)
High school graduation
Last day of elementary school
Last day of middle school
Staying home sick

Social

A party
Giving a gift
Receiving a gift
Saying goodbye to someone
Feeling angry at someone
Going to a dance/prom
Buying an expensive dress
Surprise party
Being visited by someone

Transition

Buying a car
Moving out of parents house
First bicycle
Buying a house
Moving
First time driving a car

Travels

A Vacation
Camping outdoors
Going away on your first trip
Seeing the ocean
Seeing mountains
Being in a boat
Being on a ship
First plane flight
First train trip
Going to summer camp
1st long journey/overseas
A long drive

Triumphs

Voting
Performance success
An award
Winning something
Building/constructing something
A great play (sports)
Giving assistance to someone
Making a large purchase

Detailed Instructions for the P-SAI and G-SAI, taken from Supplementary Material of Melega et al., (2024)

Below are the detailed instructions given to participants, separately for P-SAI and G-SAI. In *italics* are the verbatim instructions given to participants, while the normal text are notes for the reader to improve the understanding of the procedure.

Personal Semantic Interview Instructions

In this section, we are not interested in specific events from you past, but in general information about you. For each chapter, I will ask you to give me a brief description of that period of your life and then I am going to ask you more specific questions. I am not looking for detailed events from you past, but only for general information that describe how that chapter was like for you. For example, describing where you would usually go on holidays would be good, however, I don't need to know about a specific incident that happened on a particular day from these holidays. I do not need to hear about everything that happened during that time period, but I am interested to hear a concise overview of how that period of your life was like in general. Our interest is not so much in which facts or information you choose, but rather how you describe them. Be sure to only choose information that you feel comfortable discussing in detail. Do you have any questions?

Free Recall

Let us start with the first chapter: if you wanted to tell someone how (life chapter title) was like for you, and you only had few minutes to give them a brief overview, what would you say?

General Probe

At the end of the free recall, participants are given a general probe: *Is there anything else that is important to complete your brief overview of that time period?*

Specific Probing

The specific probing starts from the material that the participants spontaneously recalled in the free recall. Use this information as a base. "You said to me that you ... can you tell me about other (activities, traits or facts)?" Now we are going to ask you more specific questions about the lifetime chapters that you provided. *As before, we are not interested in a detailed description of everything that*

happened in your life, but we are interested in a brief description of the activities you were usually doing, the kind of person you were as well as personally relevant facts. In this section of the interview, it is important to work with the information the participant included in the Free Recall (e.g., using the information given as examples for each probe).

Repeated Events. *Think of the activities you were doing regularly during (lifetime chapter): Can you briefly tell me about your weekly habits and routines? Chose a few of your frequent hobbies and tell me about those / can you tell more about your frequent hobbies at that time? Can you tell me about other relevant activities you were doing regularly over these years?* The researcher should ask each question separately.

Self-Knowledge. *Think of the kind of person you were during (lifetime chapter): Which personality traits and character best described you? Did you have particular opinions and beliefs at that time? (e.g., related to the world, your personality or your goals at the time) Were there particular things that you liked and loved? (e.g., preferences and tastes).* The researcher should ask each question separately.

Autobiographical Facts. *Think of personally relevant facts that characterized your (lifetime period): Which personally relevant facts would you include to create a skeleton of your biography in that period?* (here, it is important to work with the facts that the participant included in the free recall) If participants are not sure about the meaning of "facts", we could rephrase the probe (e.g. which personal information or important event would you include to describe those years). *Who are the most relevant people you were interacting with during this period (friends, family, colleagues, and teachers)? Which places were most relevant to you in that period? You can think of places where you lived/studied/worked.* The researcher should ask each question separately.

General Semantic Interview Instructions

Now we will do something different. Instead of asking information about yourself and your personal past, I am going to ask you about the public events that defined the last year. You could think of public events in your environment and social context, such as politics or culture (film, music, and fashion), as well as relevant famous people at that time. Do you have any questions?

Free Recall

If you wanted to tell someone what was going on in your community, your country or internationally, during the last year, and you only had few minutes to give a brief overview, what would you say?

General Probing

Is there anything else that is important to complete your brief overview for the last year?

Specific Probing

Now I am going to ask you more specific questions about the world knowledge you have for that time. As before, I am not interested in a detailed description of everything that happened in the world, but I am interested in a brief description of the information you think are mostly relevant. Can you tell me information about: Public events that happened during that time (things that were in the news) in your community or in the world; Famous public figures during that time in your community or in the world; Trends and things that were popular in your community or in the world at that time (e.g., films, music, fashion)? The researcher should ask each question separately.

Appendix H: Participant Information Sheet

School of Psychology



Examining personal semantics within the autobiographical interview

Participant Information Sheet

Thank you for your interest in this study. Before you decide whether to take part, please read the following information carefully (this sheet is for you to keep). You may ask me any questions if you would like more information.

What is this research looking at?

Current methods of measuring memory performance in individuals are mainly focused on recall of events. We are interested in improving these methods by including measures of memory for general facts (e.g., public events) and personal facts (e.g., names of friends)

Do I have to take part?

It is up to you to decide to join the study. We will describe the study and go through this information sheet. If you agree to take part, we will then ask you to sign a consent form. You are free to withdraw at any time, without giving a reason. This would not affect you in any way.

What will happen if I agree to take part?

If you agree to take part, you will first complete a series of neuropsychological tasks which measure your semantic memory, language ability, verbal and non-verbal memory. Please note that many factors can explain performance on the test, for example anxiety, bad mood, lack of sleep. Please remember that the researchers of this team are not trained to interpret neuropsychological tests in a clinical setting, only as part of doing research. We are looking for participants who obtain a pattern of results on certain cognitive tasks. Following these tasks the researcher will then complete the autobiographical interview with you, which asks you disclose memories for events from your childhood, adolescents, adulthood and recent years. You will be asked specific details about the event and surrounding time period including; time, place, associated thoughts etc. The duration of the interview is about one hour.

Are there any problems with taking part?

You may experience fatigue. We will give you frequent breaks, and you can request as many as you wish. If you experience any irritation or inconvenience during the study, you can choose to stop at any time. You can also choose to skip any questions if you feel uncomfortable with providing an answer.

Will it help me if I take part?

You will not directly benefit from taking part in this study, but your participation will benefit the programme of research.

How will you store the information that I give you?

All information which you provide during the study will be stored in accordance with the 2018 General Data Protection Regulation and kept strictly confidential. The chief investigator will be the custodian of the anonymous research data. Any identifiable data will be stored separately in a password protected file and will be securely disposed of as soon as it is no longer necessary, and within 5 years. All anonymized results will be stored indefinitely in order to comply with open practice standards. The electronic data will be stored on a password protected computer. Your consent forms and paper based demographic questionnaire will be locked in a storage cabinet within a locked office. You are issued with a unique participant code, your name will only be linked to this code within a password protected file on a computer, all other data will be linked exclusively to this code and not your name. Only Dr. Louis Renoult and his research team will have access to this data. We adhere to the ethics committee's protocols on data storage.

How will the data be used?

The information obtained from this study will be presented at scientific conferences and in scientific journals, but your name will never appear in any public document. Only group data will be presented.

What happens if I agree to take part, but change my mind later?

You have the right to withdraw from the study at any time during the testing session, and up to 48 hours after leaving the lab and your data will be immediately destroyed. If you wish to withdraw your participation after leaving, you will be instructed to email the lead investigator with your participation code.

How do I know that this research is safe for me to take part in?

All research in the University is looked at by an independent group of people, called a Research Ethics Committee, to protect your safety, rights, wellbeing and dignity. The study received ethics approval from the Psychology Research Ethics Committee at the University of East Anglia (date to be specified).

You are under no obligation to agree to take part in this research.

If you do agree you can **withdraw at any time without giving a reason.**

Researcher contact details:

Dr.Louis Renoult, Principle Investigator & Project Supervisor, l.renoult@uea.ac.uk

Riccardo Sacripante, ClinPsyD Researcher, r.sacripante@uea.ac.uk

Do also contact us if you have any worries or concerns about this research.

School of Psychology Ethics Committee:

ethics.psychology@uea.ac.uk; Phone 01603 597146

Head of School Professor Neil Cooper: neil.cooper@uea.ac.uk; Phone 01603 592996

Appendix I: Consent Form

School of Psychology



Consent Form

Examining personal semantics within the autobiographical interview

Research Team:

Dr Louis Renoult, Principle Investigator & Project Supervisor;
Riccardo Sacripante, ClinPsyD Researcher

Please initial
all boxes

1. I have read and understand the information sheet and have had the opportunity to ask questions and have had these answered satisfactorily.
2. My participation is voluntary and I know that I am free to withdraw at any time, without giving any reason and without it affecting me at all
3. I know that no personal information (such as my name) will be shared outside of the research team or published in the final report(s) from this research
4. I agree to take part in the above study

Participant's signature.....Date.....

Researcher Contact details:

Dr.Louis Renoult, Principle Investigator & Project Supervisor, l.renoult@uea.ac.uk ;

Riccardo Sacripante, ClinPsyD Researcher, r.sacripante@uea.ac.uk

Do also contact us if you have any worries or concerns about this research.

School of Psychology Ethics Committee:

ethics.psychology@uea.ac.uk; Phone 01603 597146

Head of School Professor Neil Cooper:

neil.cooper@uea.ac.uk; Phone 01603 592996

Appendix L: Debrief Form

School of Psychology



Debrief Form

Examining personal semantics within the autobiographical interview

Thank you for participating in this study. Your time and efforts are much appreciated.

The purpose of the study is to look at improving current measures of memory performance. Current interview techniques are focused on the recall of autobiographical events, which is only a portion of the declarative memory system related to personal unique events. We are interested in improving these methods by including measures of the other components of declarative memory: general semantic memory (our general knowledge about the world) and personal semantic memory (knowledge of one's personal past). It is hoped that this research will lead to a singular measure of episodic, semantic and personal semantic memory.

If you have any questions regarding this study please feel free to ask or contact the researcher or supervisor of this study now, or at a later date.

If you would like to withdraw your participation up to 48 hours after leaving the lab please email the lead investigator quoting your participant ID which is and your data will be destroyed.

General Sources of Support

1. Seeking help or information for emotional difficulties and/or memory concerns

The first step in accessing help is to discuss the problem with your GP. They will be able to advise you on access to local resources and refer you on if appropriate.

2. Useful web sites

The British Association of Behavioural and Cognitive Psychotherapies (<http://www.babcp.org.uk>) This site offers a 'user's area' with information on mental health difficulties and a facility to help you find an accredited cognitive behavioural therapist.

The Changing Minds website (<http://www.rcpsych.ac.uk/campaigns/cminds/>). This site is produced by the Royal College of Psychiatrists and provides information and advice about mental health issues. The website contains on-line leaflets about several topics including anxiety, depression, anorexia and bulimia.

Mind website (<http://www.mind.org.uk/>) is supported by a leading mental health charity in England and Wales and also provides high-quality information and advice about mental health issues.

The Alzheimer's Society (www.alzheimers.org.uk) provides information on dementia and a directory of help available locally. The website offers an online forum.

If you would like to receive a report of the main findings of the study (or a summary of the findings) when it is completed please contact the researcher, however individual feedback on your results cannot be given.

- **Thank you** again for your participation!

Researcher Contact details:

Dr Louis Renoult, Principle Investigator & Project Supervisor,
l.renoult@uea.ac.uk ; Riccardo Sacripante, ClinPsyD Researcher,
r.sacripante@uea.ac.uk

Do also contact us if you have any worries or concerns about this research. School of Psychology Ethics Committee:
ethics.psychology@uea.ac.uk; Phone 01603 597146

Head of School Professor Neil Cooper: neil.cooper@uea.ac.uk; Phone 01603 592996